THE
ENGINEERING MAGAZINE
VOL. XVIII. NOVEMBER, 1899. No. 2.

STANDARDISING IN ENGINEERING CONSTRUCTION.

By Sir Benjamin C. Browne.

II.—THE ADVANTAGES OF SPECIALISATION IN DESIGN, MANUFACTURE, AND SALE OF PRODUCTS.

"A COMMON smith, who, though accustomed to handle the hammer, has never been used to make nails, if, upon some particular occasion, he is obliged to attempt it, will scarce, I am assured, be able to make above two or three hundred nails in a day, and "those, too, very bad ones. A smith, who has been accustomed to make nails, "but whose sole or principal business has not been that of a nailer, can seldom, "with his utmost diligence, make more than eight hundred or a thousand "nails in a day. I have seen several boys, under twenty years of age, who "had never exercised any other trade but that of making nails, and who, "when they exerted themselves, could make, each of them, upwards of two "thousand three hundred nails in a day. (Smith's Wealth of Nations)."

The above extract taken from a book published in 1776, and held to be a standard work ever since, sufficiently explains the importance of repetition, and of standardising our products as much as possible. It is often said that repetition work lowers the workman, makes his work purely mechanical and less interesting, and, therefore, makes him less intellectual; but we believe this view has no foundation in fact, as far more grasp of intellect is required to organise an economical system of standard reproduction, to carry it on, and to meet any irregularity or other defect in the system that may arise, than is required to do an isolated piece of good work, and the former certainly requires far more quickness and more sustained attention than the latter.

Sir Benjamin Browne's third and concluding article on this topic, in the December issue of THE ENGINEERING MAGAZINE, will deal with the influence which modern methods of intensified production are likely to exert upon the workman. It is a question which many

Copyright, 1899, by John R. Dunlap.

A man who turns out a single piece of first class work may nevertheless dawdle and waste his time over it; but a man who has to work as part of a system, or to keep a number of machines going at high pressure, can neither dawdle nor get slovenly. He must keep his wits about him the whole time, and it is probable that not only will the day pass more quickly with him, but he is gradually qualifying himself to become a leader of men, in a way that is not open to the solitary workman, however skilful he may be. It is, in fact, to a great extent, a question of intellectual ability *versus* manual skill, and we would again call the reader's attention to the fact that standard work almost always is first class work of its kind and requirement. If a hundred pins are to be fitted indiscriminately into a hundred holes, it can only be by their being true, and exactly the right size, and, the more complicated the piece of work, the more perfect each part has to be to make that interchangeability which is the very essence of standardisation.

We will now approach this subject from the point of view of the man who intends to start new works—that is, from the viewpoint of the would-be capitalist, and would-be employer of labour.

Strange though it may appear, it is probable that few men, when they begin to form a business or lay down a works, ask themselves exactly what size of business they propose to undertake. They seem so afraid of cutting off any possible source of profit that, though they may have a central idea, the boundaries of their business are hardly fixed at all, or are marked out in their own minds in so vague and so undecided a manner that they vary them on the slightest pressure or impulse. This very commonly brings to them a large volume of unprofitable work, which swallows up the profits on their first-class business. It also injures their prestige, by inducing them to take up work with which they are not thoroughly familiar, and to put out designs which have not been thought out so fully and so carefully as they ought to have been.

Of course, there is a constant anxiety to please possible customers; but it seems to be the experience of most firms that work very closely to standards and object to making alterations, that complaints and criticisms almost always come from prospective purchasers, and that those who have actually bought their products are more thoroughly satisfied with them than they would be with those of a maker who

approach with apprehension. Sir Benjamin is an apostle of hope; his paper will point clearly and confidently to the advantage which labour, as well as capital, is sure to reap in the new era of concentration and specialisation. THE EDITORS.

tried to please everybody's inexperience and pre-conceived theories. I will take the liberty of again quoting from "Chordal's Letters," as an illustration of my point, the following description of the way in which a careful American takes up the manufacture of a specialty:

"As an example of New England operations, let me cite one case: A steam engine of entirely new type was devised. It was taken to a celebrated concern. It was approved, and taken in hand. An engineer skilled in the science of steam and mechanics re-designed it. An engineer skilled in manufacturing joined hands and heads with the steam man, and the result was a machine which looked all right to the steam man, and which the factory man said he could make well, and cheap, and profitably. Then a few were made as any single article would be made.

"In the west these few engines would have been sold and some money brought in. But not so in this case. These engines were put to work, surrounded by skilled tests. They confirmed the judgment of the parties who were 'looking into it.' Did they go to work and sell them then? No, sir. They then began the tests for durability. Hour after hour, and month after month, every hour that there was steam in the factory boilers, did these engines whirl away at their heaviest loads, under every possible change in work and handling, and under the closest of scrutiny. They are running yet, and will be running next Christmas. When this test is over, will these factory people commence to make this engine for sale? I doubt it. I do not think they will ever 'make' these engines. When the tests are over, the system of manufacture, already in view, will be elaborated, and then a fortune will be expended in appliances; and then, and not till then, will the public be asked to buy. The engines will be manufactured, not 'made'; and that 'manufactured' means a well studied and economical production which is to the benefit of all concerned. All this, of course, in case this engine proves 'durable.' It may be disappointing, in which case the whole thing will go into the scrap pile; and the cost will be charged to expense, and will be a small loss to a concern which has accumulated millions of dollars by a continued demand for articles treated in the same careful, cautious, pains-taking manner.

"These heavy investments, based on a hope of future return are not an inventor's worship of his idol. This engine came from afar. These are capitalists looking up investments."

Now, probably, to perfect any product in this way is rather the mission of an old capitalist than of a young man starting first in busi-

ness; but the process of thought ought to be the same in both cases, and anyone beginning a business ought to satisfy himself that there is some opening or sphere in the world, however small, which he must succeed in filling, to the advantage of society at large, somewhat better than it is filled at present; and he ought to realise that, after all, only a fractional part of his fellow creatures can ever be his customers, and he must not be unduly afraid of losing a few of those, who would do business with him if he were somewhat different.

Supposing a man decides that he can make a certain lathe, steam hammer, or other tool, that will cover a recognised want—say it is either a size larger, or a size smaller, than is generally used, or that it performs some recognised process more quickly and cheaply, or with less trouble to the operator, than the appliances ordinarily in use. Of course, his difficulty is that, though he may make something very perfect, he must also succeed in selling it; and to sell it, he must be able to bring it sufficiently easily before the public. Now here we come to a point, which is not nearly sufficiently recognised in manufacturing—that a manufacturer must have three entirely different qualifications, or buy them from someone else, who will then become, to that extent, his servant or partner.

First of all, as described in the extract we have given, the machines, or whatever he means to sell, must be thought out and designed to be as perfect as possible. This requires a wide range of information, good scientific training, and ability. It is, in fact, the most perfect development of the work of the draughtsman, and probably one of the most important things to impress on the young manufacturer—or, for the matter of that, on all young engineers—is, that whatever they sell ought to be the best possible article for the purpose for which it is intended; not necessarily the best possible article in itself, because an article may be too costly for its special purpose. If it is only to be used rarely, or for a short time, it is no use spending money to give it a finish, or a durability, which would be very properly applied to work of a more permanent character.

For example, on public works, cranes, roads, and other things are put up which will very likely be swept away, or thrown on the scrap heap, at the end of a year or two. Now, a man might find it his business in life to make cranes of a transitory character for public works; and, if so, to make them quickly and cheaply and so as to be easy of erection, which would be more important than to make them thoroughly durable.

We see, in our extract from "Chordal's Letters," that the manu-

facturer apparently employed an outside engineer skilled in the science of steam and mechanics, to re-design his engine—or, possibly, two engineers in combination. This is one way over a difficulty, and manufacturers probably would be much wiser, if, whenever they want anything that is not exactly in their own range of experience, they would go, far more often than they do, to some other engineer, who has made a specialty of what is wanted, and pay him for his advice. It is probably the case that comparatively few engineering manufacturers, when (for example), they start a foundry, go to some outside man, who has made a specialty of foundry work, to design it for them; and yet on the way in which a foundry is laid out will probably depend entirely the question of whether it is a source of profit or los to the owner.

The second point on which a manufacturer wants to be qualified is, as a manufacturer—that is to say, as a manager of works. Having got his drawings made, the question then is to manufacture his article in the cheapest, quickest, and most efficient manner.

The third point is, of course, the work of bringing his manufactured articles before his customers, and selling them; and also the work of buying; we will not discuss these at present, however, but will dwell on the second point.

It is quite clear that this involves a wholly different class of experience from that required for the first qualification, and, while the need of high theoretical knowledge and training is less obvious, the need of long years of actual workshop experience is more obvious. In fact, we may say that for the draughtsman, science probably comes first, and experience second; with the workshop manager, experience first and science second. Nothing but long years of experience will really enable a man to get the very best results out of his tools and out of his men, or to select the most suitable man for each particular part of the work. For this reason, the making of standard articles is an especially suitable ladder by which the working man may climb into the position of a capitalist.

In the last paper, a description was given of the work of a subcontractor, or middle man, supposed to be a Yankee, and we are told by "Chordal" how he makes his way into a workshop to the benefit of all concerned. Now, what this Yankee contractor did may be done equally well by a small employer who has time to look thoroughly into his own business; but it is very important that the man who manages the shop, whether owner or official, should have power to try reasonable experiments and to make reasonable alterations, at his own dis-

cretion, without having at every step to obtain permission from and explain his policy to some higher power.

Of course, this power is all very well in the hands of a man of ability and integrity; but many men are never qualified to use it, and often men in such a position, if they are spending somebody else's money, lose their heads and get into all kinds of extravagance. As, however, the sub-contractor is so rare in England, we must hope to see his place supplied by the employer himself. That costs may be frequently reduced 20, 30, and 50 per cent. is within the knowledge of every practical man. In fact, the A. B. C. of engineering manufacturing is the enormous economy that is made by repetition, and the great margin for reducing the price and increasing the quality of work by high class appliances. It ought, of course, to be obvious to everybody that no manufacturer can expect to make money unless he has both the knowledge and the capital to enable him at once to adopt the best and cheapest possible means of doing each atom of his work; and, practically, to revert to the position of the man who is going into business, this must not be taken to mean always that he ought to have more capital—very often it means that he ought to have smaller works. In other words, given a man with a certain amount of capital, how is he to utilise it to the best advantage to himself? Suppose a man has £6,000. He would probably start works to employ about forty men, and should sell, each year, about £9,000 worth of finished machinery. These figures will vary very much according to the branch of trade in which he is engaged, but those stated are probably a fair average, and will answer our purpose. He then ought to review in his mind the possible class of work and number of articles that he will have to dispose of, and he must ask himself very seriously whether he can afford to put up the very best appliances, to enable this work to be turned out as cheaply as possible.

Taking men, boys, and labourers, all round, his wages bill will come to about 30 shillings per week per man, or say £3,000 a year; so every saving of 2 per cent. on his labour is equal to an increase of dividend of 1 per cent. on his capital. I have purposely made no allusion to borrowing powers. A man who can spend £6,000 on his works could certainly borrow, say, £3,000 more, but he will probably do better to keep that power in reserve, either to meet some unforeseen calamity, or to enable him to take advantage of some very exceptional opening that might arise afterwards.

Before our capitalist organises his works, he ought to take great pains to see as many as possible of other people's works, of a similar

character, and also some of those of a somewhat different character which he understands to be specially well organised. It may be taken for granted that an employer, or a manager, who does not care to know what other people are doing, is certainly not in the way to make money. One of the best manufacturers that England ever saw used constantly to say that scheming was all very well, but what was really important and difficult was to find out what other people were doing. An employer on a large scale should never hesitate, if he has a chance, to buy up any man, whether opponent or otherwise, who understands some branch of his business better than he does himself. Few people, who think the question out quietly, will deny that business success is a constant struggle between a man's vanity and his thirst for knowledge; and it is surprising how common it is for a man to be kept among the unsuccessful all his life, simply because his vanity would not allow him to say to himself that he has been wrong, that somebody else knows better than he does, that he must change his system, and copy some other man if he wishes to succeed.

We all know how "Ready Money Mortiboy" told the village children that if they wanted to get on they must be discontented. This advice very much shocked the clergyman, and requires to be taken with some modification; but it had, from the manufacturer's point of view, one very strong element of truth, viz:—that no one ever ought to be satisfied with the results he is attaining; that whatever the cost of his work was last year, he ought to be dissatisfied if, under similar conditions, it is not somewhat less this year; and, as we have already seen that, roughly speaking, a man pays away every year in wages an amount something like equal to half his capital, it is obvious that if he can diminish the cost of his labour 2 per cent., or make his men and machinery turn out 2 per cent. more work in the same time and at the same cost, he is adding 1 per cent. to the dividend that he can pay on his capital. The question of paying 2½ per cent. dividend, more or less, may make all the difference whether a works shall be looked upon as successful or unsuccessful, and yet this great result may be simply a question of adopting labour-saving appliances so as to increase the output 5 per cent. without increasing the expense.

Most of us remember the great economy that came in when we took to stamping all sorts of small smith work under a steam hammer. Some people thought the days of blacksmiths were numbered, and that we should soon want none of them, but they have not become extinct, nor fewer, nor are their wages lower.

The same applies to other trades, wherever labour-saving appliances have been introduced. It is the same story; the cheapening of the selling price of the article has so increased the demand that the relative economy in labour is far more than covered by the absolute increase in consumption.

It may be thought that standardising is crystallising, and so stopping all progress; but this is not so—indeed, it cannot be. If a manufacturer were so wedded to his present standard that he refused to improve it, as time went on he would simply find himself superseded by other manufacturers. The needs of the world and the growth of invention set the pace of progress in these matters, and the question of standardisation only lies within these limits.

For instance, no one standardises more than a hatter. He turns out ready-made hats by the thousand, and yet the fashions in hats may alter every year. But the point is this: if he makes a large number exactly alike, the cost of the appliances for making them is spread over a larger number, or, in other words, the larger number he can make before the pattern has to be changed, the more costly and elaborate appliances he can afford to use in manufacture.

The changes will come at the same intervals of time, whether he manufactures many or few; and, supposing he has to remodel his plant once a year, the object is to make the greatest possible number out of the plant every year. So, in engineering, the requirements of the world and the skill of inventors will force periodical revisions of type, but the profit is made in making as many repeats as possible before the change comes. In short, suppose the letters of the alphabet represent twenty-six manufacturers, and there are twenty-six types of lathe, donkey engine, boiler mountings, or anything else, to be made; it would be ideally better for A only to have the plant for making one type, and get all the orders for that type and size. B would have the plant for another type and size, C for a third, and so on.

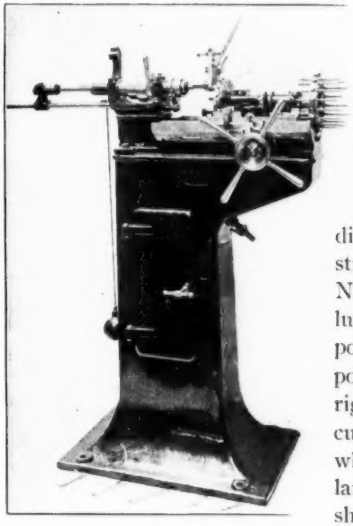
Of course, this is a counsel of perfection, but it is the ideal to be kept in mind; and above all, let every manufacturer remember that, to be successful, he must supply an article exactly suitable to the needs of the public, and manufacture such article in the cheapest and most accurate manner possible.

In a further paper, this question will be looked at from the point of view of the working classes, and the way in which their interests are affected.

THE REVOLUTION IN MACHINE-SHOP PRACTICE.

By Henry Roland.

II.—THE DEVELOPMENT OF THE AUTOMATIC SCREW MACHINE.

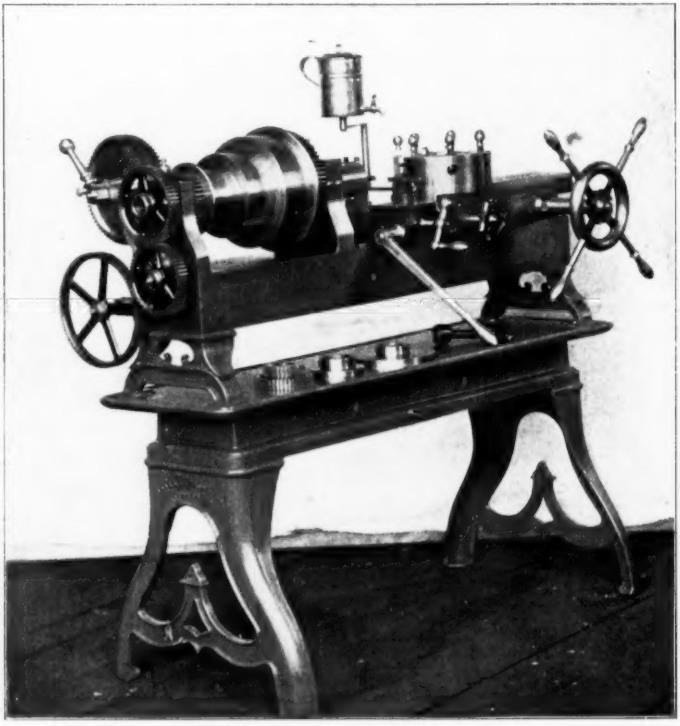


A GERMAN REPETITION LATHE.

THE slide rest, as first brought out by Maudslay, was a sliding piece of metal, moved by a screw, and so secured to its support that, while it was capable of being moved freely in one direction, it was rigidly confined in all other directions, within the machine-construction sense of the word "rigid." No mechanical structure is absolutely rigid, and no cutting tool supported on a slide rest is rigidly supported so as to be moved in exactly a right line of travel, and no metal-cutting machine produces surfaces which are geometrically flat, circular, or spherical; but in a machine-shop sense, and for all practical purposes of ordinary machine use, good lathes produce round work and good planers produce flat work. Where a close approach to accuracy is needful, the imperfect work of the lathe and planer must be bettered by hand scraping, by lapping, and by grinding. Scraping is purely a hand operation, tested constantly in course of production by the use of hand-applied plane surfaces called "surface plates," which have close approximations to geometrically plane surfaces. Internal lapping, flat lapping, and cylindrical and conical grinding are all mechanical operations, and neither scraping, lapping, nor grinding is considered in these articles, which relate solely to the savings in labor cost of mechanical forms of metal which are made possible by the use of Maudslay's slide rest; this slide rest being fitted to carry a single cutting tool, rigidly secured to one of its exposed surfaces, which was

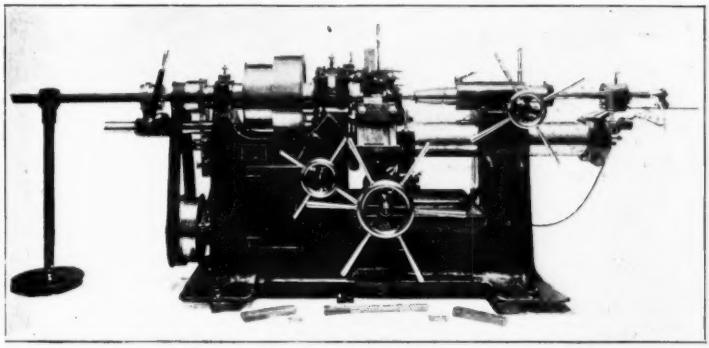
the extent of its powers as developed by the early English tool-makers, or being fitted with turrets, as devised by American tool-makers in 1856 or 1857.

Generally speaking, Maudslay's slide rest, as applied to machine tools, carried but one single metal-cutting edge, and hence could form only one single finished surface on the work without a change in the



A TURRET LATHE FOR GENERAL USE.
Made by Jones & Lamson about 1881.

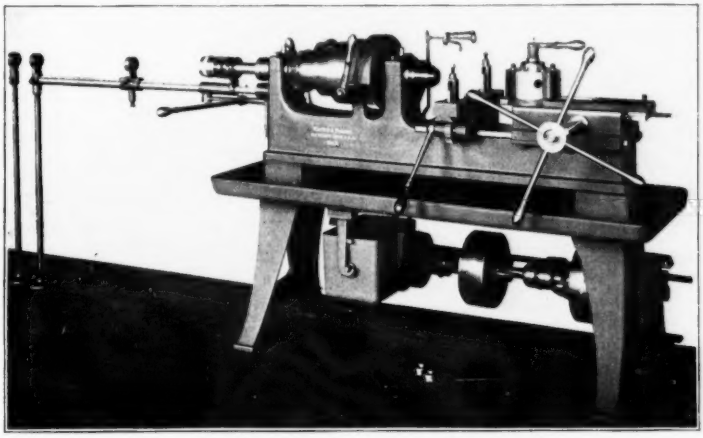
form, position, or direction of motion of the cutting edge. These cutting edges, when used in the ordinary lathe and planer, are called simply "tools," each special form of "tool" having its particular name, as "diamond point," "side tool," "parting tool," "boring tool," and so on in great variety. All tools of this simple character are commonly forged on bodies of the same rectangular shape—that of the bar of



GERMAN FORMING LATHE FITTED FOR MAKING BICYCLE HUBS.

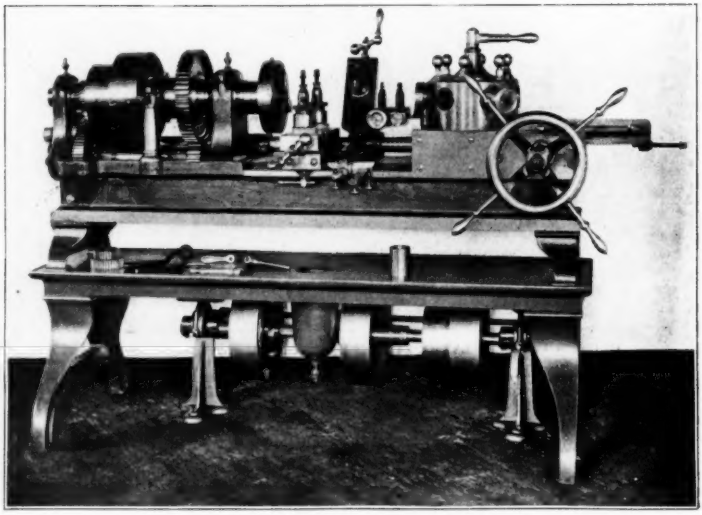
The machine weighs about 4 tons, and admits a 3-inch bar. Its peculiar feature is the massive cylindrical bed around which the tool-holder oscillates. As shown above, four tools are in operation—a borer, one broad-roughing, one finishing, and one parting tool. It will turn out an ordinary cycle hub from the rough bar in about 2½ minutes. Made by Pittler, of Leipzig.

tool steel from which they are produced by the tool-smith, who forges and tempers them—and are ground and set in place in the "tool-post" forming a part of the slide-rest slide by the mechanic who attends the machine tools in which these simple cutting tools are used. The shape of the cutting edge and its position in relation to the moving surface



REVOLVING-TURRET SCREW MACHINE.

Wire feed and turnstile feed to slide. Diameter of hole in spindle, 1 1/16 in. Mills a length of 6¼ in. Made by Warner & Swasey.



BRASS-WORKER'S TURRET LATHE OF ABOUT 1881.

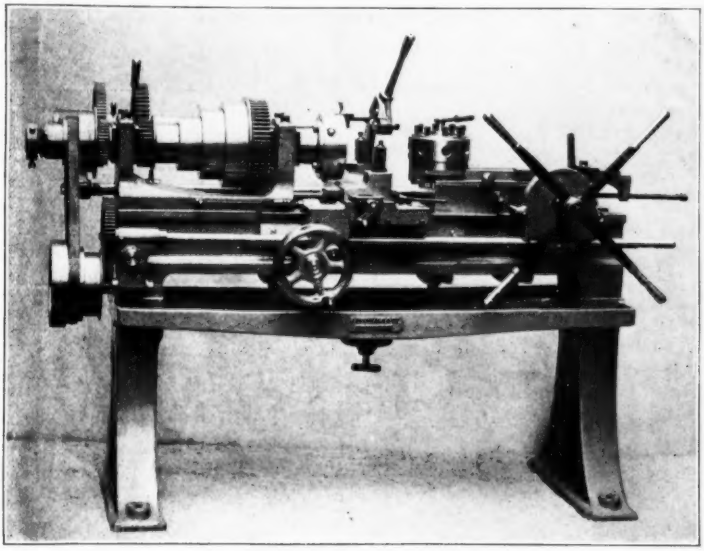
Made by Jones & Lamson.

to be cut are determined by the workman, and the work is produced by a succession of roughing and finishing cuts passed over the surface in process of construction.

Maudslay's first slide rests were actuated by a hand-operated screw, the workman turning the screw to force the cutting edge into the moving body of metal to be cut. Very soon, however, the slide-rest screws were connected with some rotating part of the machine tool, lathe or planer, so that the workman had no work to do in the actual operating of these "self-acting" machine tools. He was thus relieved of all manual labor in the actual removing of metal, but needed great skill and intelligence to give the cutting tools their best forms, present them to the work at the best angles, and give the work the greatest velocity possible. Some workmen produced vastly more work than others with precisely the same equipment, where self-acting tools were used.

The aim of the factory manager is to make the same means produce the same piece at a maximum rate and minimum cost, no matter what workman is employed. Hence the self-acting machine tool was very early advanced to the semi-automatic tool, in which the cutters are sharpened and adjusted in fixed positions by the tool-maker, and

the machine tender is required only to perform a few simple duties, involving neither discretion nor the exercise of judgment. His labors are confined to placing rough pieces in the machine, throwing cutting tools into action, and replacing the finished pieces by fresh rough pieces. But, even with the semi-automatic machine tools, some workmen produce more finished pieces than others, owing to superior intelligence and aptitude and willingness, and hence, in all cases where the size of work and the quantity of pieces demanded will permit, the full-automatic machine tool, which both handles and finishes the work, is now employed. The result is the diminishing of labor costs to a mere fraction of the labor costs incurred in producing the same piece by machine tools of the general "self-acting" class. With the full-automatic machine tool, the labor costs of work production are confined to the tool room; material, power, and lubrication, and the apportionate share of general expense, added to the tool-making account, make up the whole flat cost of the piece produced, and—a matter of the highest commercial importance—the manager finds his piece cost remaining nearly constant. If it varies, it is only in accordance with obvious



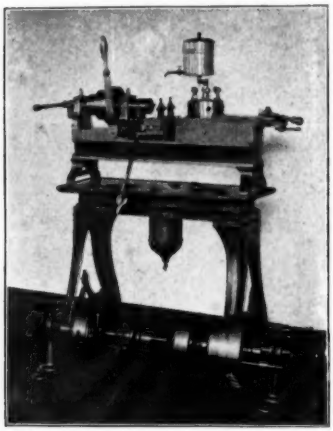
AN ENGLISH CAPSTAN LATHE.

Admits a 2-inch bar through spindle, and can turn a length of 9 inches. The turret slide is self-acting and self-stopping, and the turret can be made to operate automatically or not at will. Made by James Archdale & Co., Birmingham.

causes, and not at the whim of the machine tender, who is indispensable in the case of the semi-automatic or self-acting machine tool, and who is wholly intractable and ungovernable, and can and does make work costs large or small at his own pleasure.

Maudslay's accurately moved slide of the slide rest is the foundation of the tool-maker's art, because no cutting, rolling, squeezing, hammering or abrading tool can be effective as a producer of uniform metal-shaping effects except when guided by a "closely" fitted sliding support. The word "closely," used in this connection, has wide limits of variation, and may mean a hundredth part of an inch in the guides of a large steam hammer, or the fifty-thousandth part of an inch in the slide of a watch-part making machine.

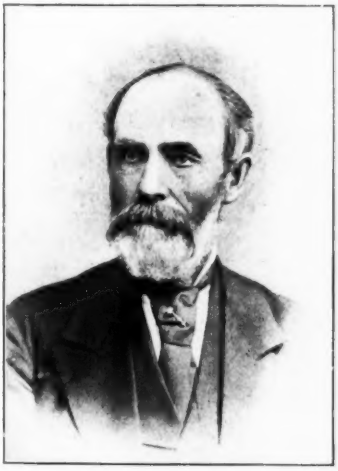
Maudslay's slide rest placed the English tool makers, for about half a century, in advance of all others, and led the English machine-tool makers to the belief that they had reached perfection and could rest where they were, because they led the world in 1845. But Maudslay's slide rest was really a very primitive element, whose powers were capable of expansion to an almost unlimited degree by compounding, and making one moving piece carry, not one single cutting edge adapted to produce one single geometric surface, but a multitude of cutting edges, adapted to be automatically moved in various directions and so to produce finished metal surfaces of any form and relation to each other on the same piece of work. This highly superior development of the slide rest is most widely applied in the form of the "turret," called the "capstan" or "capstan head" in England. The turret is purely an American invention, or at least as much so as the slide rest was an English invention. There is no doubt that both the slide rest and the turret, and perhaps even the multiple-spindle machine tool, are very old inventions. But Maudslay was the first to make a slide rest with sufficient accuracy to produce fairly good machine work, and Henry D. Stone, at that



EARLY SCREW MACHINE.

One of the first forms given to the turret lathe by Henry D. Stone. Made by Jones & Lamson about 1857.

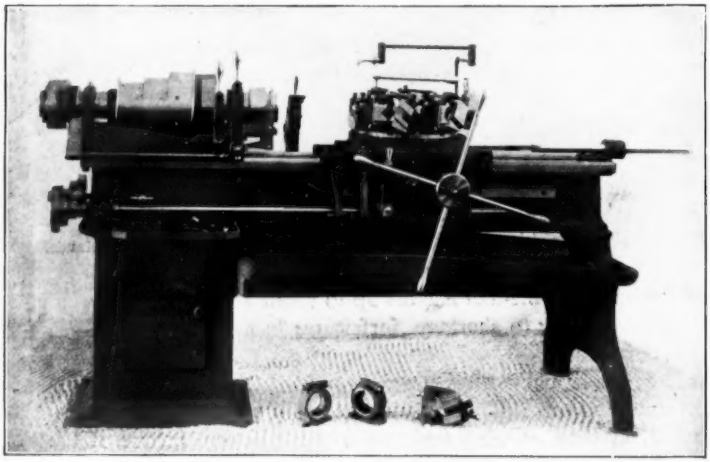
time residing in Windsor, Vermont, was the first to comprehend the advantages of applying to Maudslay's slide rest a revolving head carrying a number of metal-working tools, and capable of being either revolved or locked to the slide at the will of the operator. Thus he made the first great step in advance in machine-shop tools after Maudslay's introduction of the slide rest.



HENRY DAVID STONE.
The first great improver of Maudslay's slide rest.

Henry D. Stone was born at Plainfield, New Hampshire, August 20, 1815, and died at Windsor, Vermont, in 1898. He learned the millwright's trade at Woodstock, Vermont, and was afterward with Robbins & Lawrence, who were among the foremost of American machine-tool makers up to about 1857, when they failed in business owing to shortage forfeitures in a contract for arms furnished to the British Government, which enforced the penalties and ruined the unlucky contractors. September 20, 1899, I saw an admirable milling machine built by Robbins & Lawrence at Windsor, Vermont, in 1852, at work and held in high esteem in one of the best equipped and most modern machine-tool shops in existence; this single instance sufficiently attests the high standing of the firm, who were first of all the world to comprehend the possibilities of the milling machine in machine-part production. Upon their failure, Stone and another leased the Windsor establishment and began the manufacture of sewing machines, and this work was finally merged into the machine business of Jones & Lamson, Windsor, Vermont, Stone becoming superintendent. Stone's patents on the turret machine were taken out about 1858, and grew out of his accidental observation of some sort of a revolving head used on a bolt cutter at Hartford, Connecticut. He instantly comprehended the vast possibilities of the turret, and at once proceeded to design and produce a turret machine in the form of a lathe, having a work-carrying spindle driven at variable speeds, a cross slide on the lathe sheers carrying two tool posts in front of the axial line of the live spindle and two tool posts in the rear of the spin-

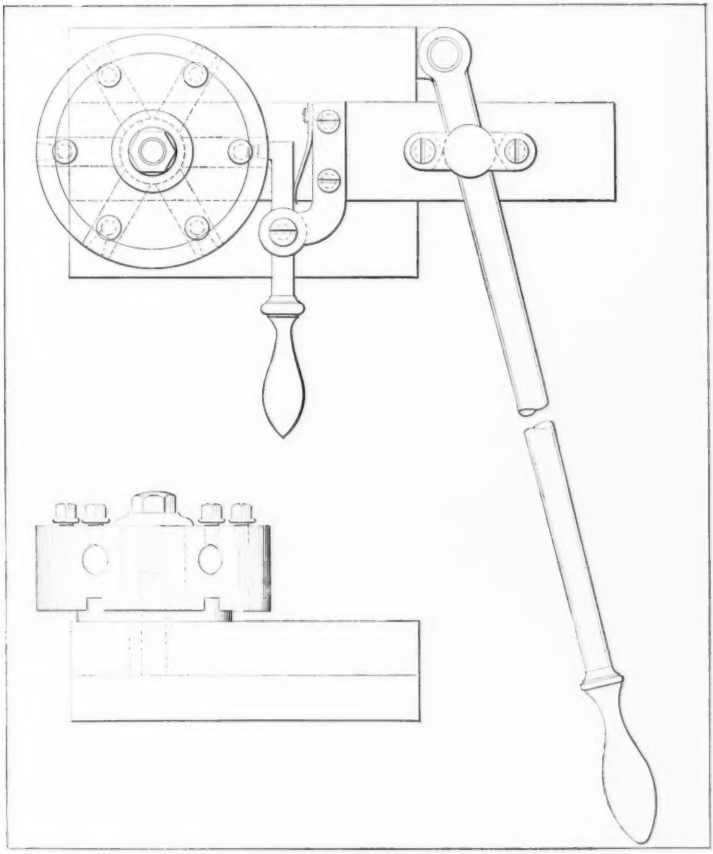
dle axis, and having, in place of the tail spindle or foot stock of the lathe, a substantial slide of considerable traverse parallel to the spindle axis, and carrying on its unobstructed upper surface a turret, supported on a vertical axis, having six radial holes in the plane of the spindle axis, and capable of being automatically turned and locked by the traverse of the slide which operated it. Thus, instead of the single cutting edge carried by Maudslay's slide rest, this new tool devised by Stone carried four tools in the cross slide, and six tools in the turret, all fixed, ten cutting edges in all, and each one capable of being brought into definite action on the work in proper sequence. This so enormously amplified the powers of the self-acting lathe as to enable



THE JONES & LAMSON FLAT-TURRET LATHE.

The turret is a flat circular plate, mounted on a carriage containing the controlling mechanism. The form and connections are designed to secure great rigidity and accuracy. Cuts 2-inch diameter up to 24-inch length.

wholly unskilled laborers, and even boys and girls, to produce small machine parts at a very trifling fraction of the labor cost of the same parts when made by the most expert turner on a self-acting engine lathe fitted with Maudslay's inventions. Stone's patents were not well drawn, and other machine-tool makers promptly took advantage of the opportunity. Brown & Sharpe and Pratt & Whitney very soon became large producers of turret machines, and the turret is now applied to machine tools of all weights and descriptions. To H. D. Stone, however, belongs the credit of having first seen and compre-

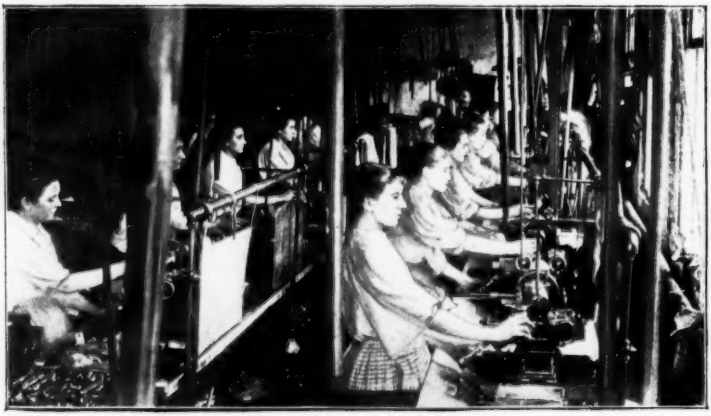


DRAFT OF THE TURRET MACHINE OF 1858.

Engraved, by the courtesy of George M. Stone, Esq., from the original drawing by Henry D. Stone.

hended the virtues of the turret, and thus laid the foundation for the use of that most valuable adjunct to the lathe, planer, milling and drilling machine, which, more than any other one detail of machine organization since Maudslay's introduction of the slide rest, renders possible the present amazing reductions in machine-production labor cost.

The form which the invention first took in his mind is clearly shown in the engraving on page 185, which is a reproduction of the



TURRET MACHINES OPERATED BY GIRLS IN THE SHOP OF THE HARTFORD MACHINE-SCREW CO.

original drawing made by Mr. Stone and bearing the date 1858 in his own handwriting. This historic draft cannot fail to excite that interest which always attaches to authentic landmarks of human progress. As shown in the drawing, the original turret was intended to be operated by hand, there being one lever for the slide and one for the turret stop.

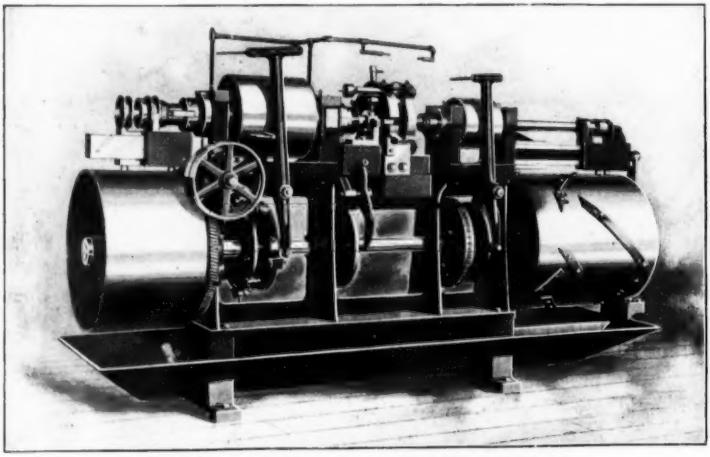
ROW OF AUMOMATIC SCREW MACHINES IN A BICYCLE MANUFACTORY.
The Lozier shops, Thompsonville, Conn., U. S. A.

But the hand-operated turret lathes, like all machines making direct use of muscular labor, were uncertain in production. Making very small pieces, the labor of traversing the turret slide is small and not very fatiguing, even when the turret machines are operated by boys and girls; but with these small turret machines celerity of movement and constant application were demanded of the operator, who could increase or diminish the part production within wide limits of variation without infringing the unwritten laws which govern the shop operative, and often forbid censure of the workman by the overlooker, even when the overlooker is convinced that the operative is willfully lax in the management of the machine entrusted to his or her direction. In general terms, all machine production which is dependent for its rapidity on the workman must be uncertain; even where the workman is sincere, and earnestly strives for the best results attainable, fatigue and physical condition often prevent reaching the maximum output, so that with semi-automatic machine tools it is common practice to estimate the probabilities of daily production at two-thirds, only, of the maximum rate of the machine when operated by a tool-maker or foreman. The only known remedy for this serious under production is the full-automatic machine tool, which does not depend in any way upon any operative below the grade of tool-maker.

CHRISTOPHER MINER SPENCER.

Christopher Miner Spencer, born at South Manchester, Connecticut, June 20, 1833, was the first to comprehend clearly the vast savings in machine-part production which are rendered possible by converting the semi-automatic turret machine into a full-automatic tool, capable of producing almost any shape of small metal piece, without human intervention beyond the placing of a bar of metal within reach of the feeding mechanism of the machine. Metal-working machines have not yet been so made that they can, of their own volition, go to the stock rack and select bars suited to the work they are fitted to produce; but at the Hartford Machine-Screw Company's works, where

the Spencer automatic turret machines were first placed in large use, it is the practice to use, say, one machine tender to ten automatic turret machines, with the result that the observer may often gaze down the long vista of a screw-machine room, and see hundreds of full-automatic turret machines busily engaged in the production of small machine parts without a single workman in sight. This magnificently economical result is due to the work of Maudslay, supplemented by that of Stone, and placed beyond the hindrance of human intervention by Spencer. From Maudslay to Stone covered a period of nearly fifty

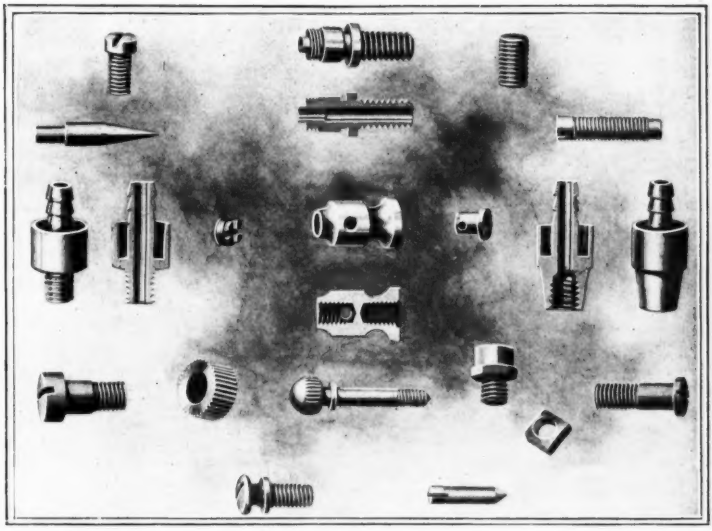


LARGE DOUBLE-TURRET AUTOMATIC SCREW MACHINE.

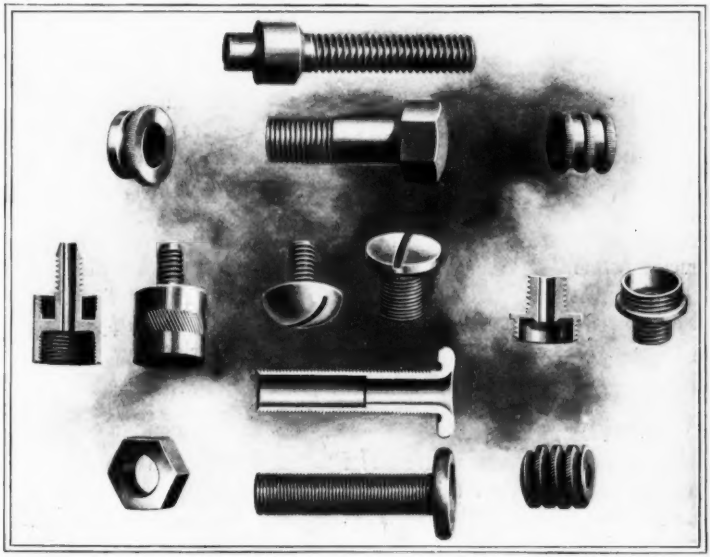
Chuck takes up to 1⅜-inch diameter, making a cut 4¼ inches long. Each turret holds five tools. Spencer Automatic Machine Screw Co.

years, and from Stone to the final completion of Spencer's work, now only just fairly on the market, nearly fifty years more were consumed, so that it may be said, with tolerable accuracy, that a whole century of observation and effort on the part of by far the best and most intelligent mechanics ever known in the history of the human race, has been consumed in perfecting the slide rest and utilizing the full scope of its powers.

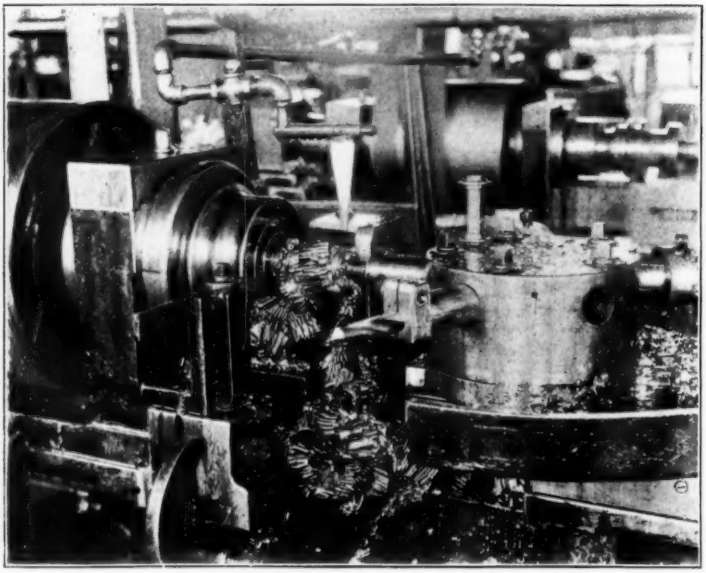
Spencer's name is widely known in connection with drop forgings, turret machines, and guns, both rifles and shot guns, small arms having been both his triumph and his bane. Spencer began his mechanical career by serving a sixteen-months' apprenticeship with Samuel Loomis, of South Manchester, Connecticut, cotton machinery builder



PRODUCTS OF THE AUTOMATIC SCREW MACHINE SHOWN ON PAGE 195.



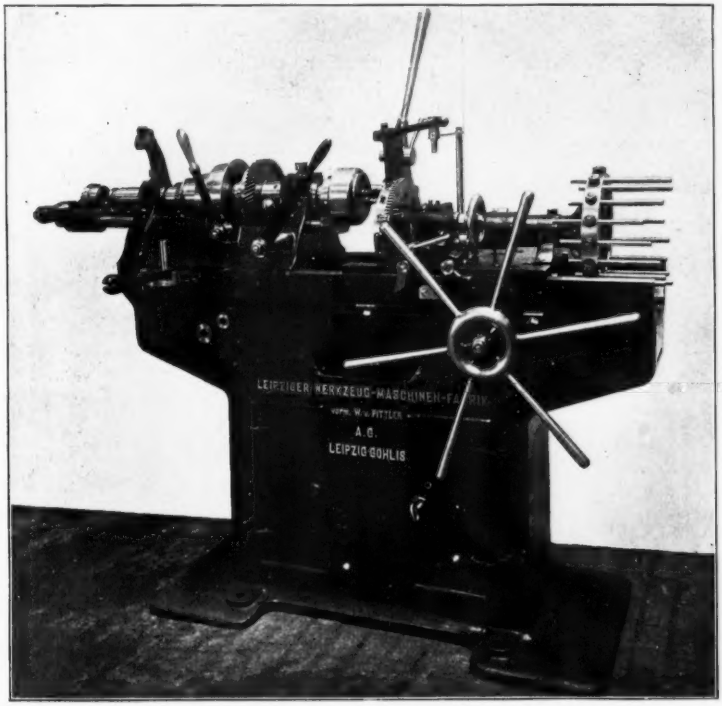
PRODUCTS OF THE AUTOMATIC SCREW MACHINE.
Made by the machine illustrated on the opposite page, and completed as shown solely by the machine itself.



BROAD CUTS ON BICYCLE HUBS.
The Spencer automatic screw machine at work in the Lozier bicycle shops.

and repairer. Next he was with the Cheneys, of South Manchester, now the great silk-mill owners, then only small makers of sewing silk. From thence he went into a locomotive-repair shop at Rochester, N. Y., and from the locomotive shop to the Ames shops in Chicopee, Mass., where he assisted in the production of musket-stocking machines for the Russian Government. He then went back again to the Cheney Brothers, in South Manchester, and there invented his first rifle, which was patented in 1860. The wealthy Cheney Brothers financed the Spencer rifle, giving the inventor a bonus of $5,000, a royalty of a dollar on a gun, and the position of superintendent of the Boston factory, where the manufacture of 200,000 Spencer rifles for the United States Government was very soon commenced. From the Boston rifle factory Spencer went to the Amherst gun shop, organized to work Spencer's inventions in sporting guns, and there lost about all the money he had. After this unfortunate venture, in company with C. E. Billings, he began the manufacture of shot guns at Hartford, Conn. The shot gun did not make money, but Billings & Spencer had laid down a fine drop-forging plant and their drop forgings are

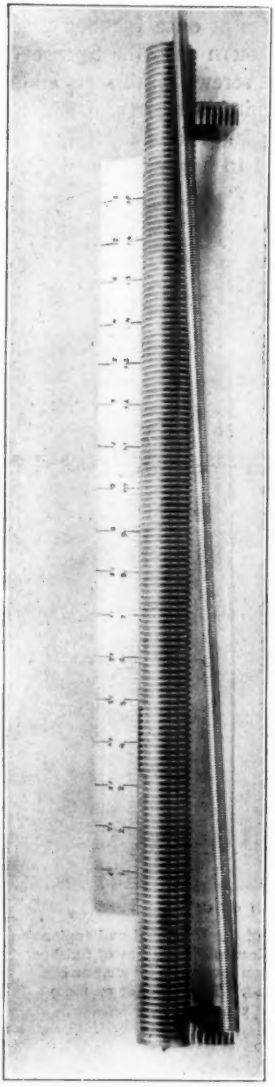
now known the world over. At the end of the last gun venture, Spencer turned his attention to the turret machine and made it automatic, and the possibilities of this new invention of his were fully comprehended by Mr. Fairfield, at that time superintendent of the Weed Sewing Machine Company, of Hartford, who at once founded the Hartford Machine-Screw Company. This concern used the Spencer automatic machines in the making of machine screws of all sorts and sizes, producing also to order an almost illimitable variety of small machine parts, with very great commercial success. Spencer went with Fairfield, and was on the high road to large wealth, when



REPETITION LATHE—A VARIATION ON THE TURRET OR CAPSTAN TYPE.

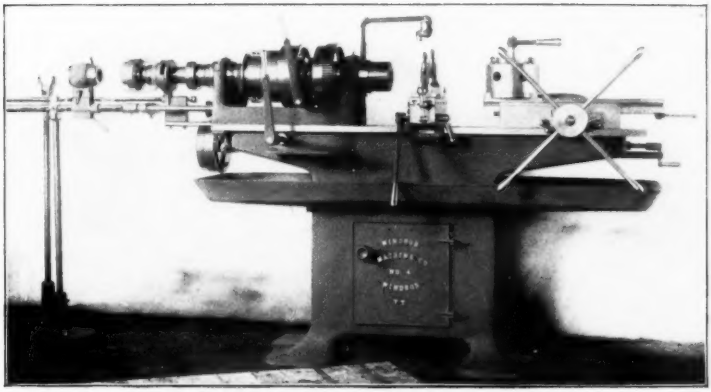
The entire set of tools for a given piece can be taken out of the tool head and replaced by a complete set for a totally different piece in a few minutes. Accuracy of finished parts is obtained by using a roughing and a finishing tool for every important cut. For extreme accuracy, even a third tool may be used. The number of tools carried is ample to leave enough others for forming, tapping, screwing, etc., so the piece may be finished in one chucking. Made by the Pittler Co.

he was unlucky enough to conceive the idea of the "trombone" shot gun, the most rapid fire sporting gun known; he sold out of the Hartford Screw Company and started a shot-gun factory at Windsor, Connecticut, six miles north of Hartford, where he sunk $30,000, and again turned his mind to the automatic screw machine, and produced the automatic double-turret machine, which can make almost any small machine part of generally circular outline, without human intervention.



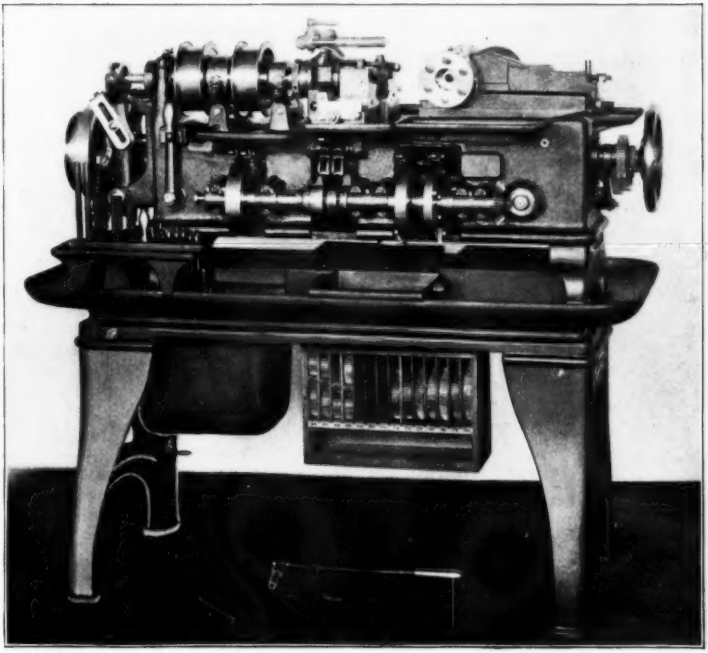
AN EXAMPLE OF ACCURATE THREAD-CUTTING ON THE AUTOMATIC SCREW MACHINE.
Thread made with Hartness automatic die on the flat-turret lathe.

In the operation of the semi-automatic turret machine, the workman has to move the turret-conveying slide toward and away from the work-conveying spindle varying distances at varying rates of travel, and to move the cross slide in both directions. The full-automatic machine must, of course, make approximately the same motions and these motions vary in sequence and extent for every different piece made. These motions of the machine parts must be given, in the full-automatic machine, by means of cams placed on a shaft which makes one revolution during the production of each piece of work, and at first sight the full-automatic turret machine would seem impossible because of the vast number and cost of the different sets of cams required to adapt the machine to anything like general use. Spencer met this seemingly insurmountable objection by inventing a blank cam cylinder of large diameter, to which small pieces of plain iron bars of



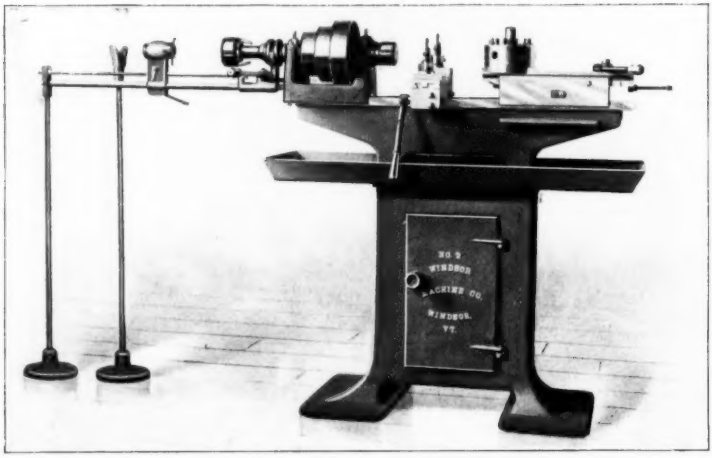
A SCREW MACHINE, 16-INCH SWING, 2-INCH CHUCK CAPACITY.

Automatic chuck and wire feed; power feed to turret and oil pump.
Made by Windsor Machine Co.



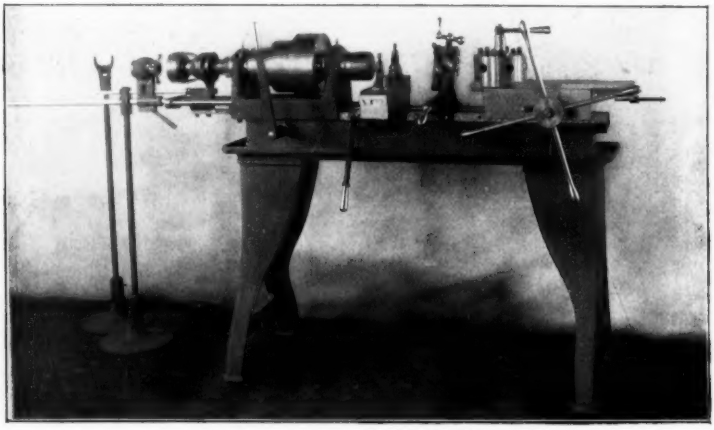
AUTOMATIC SCREW MACHINE TURNING ½-INCH STOCK TO A LENGTH OF 2 INCHES.

Made by Brown & Sharpe.



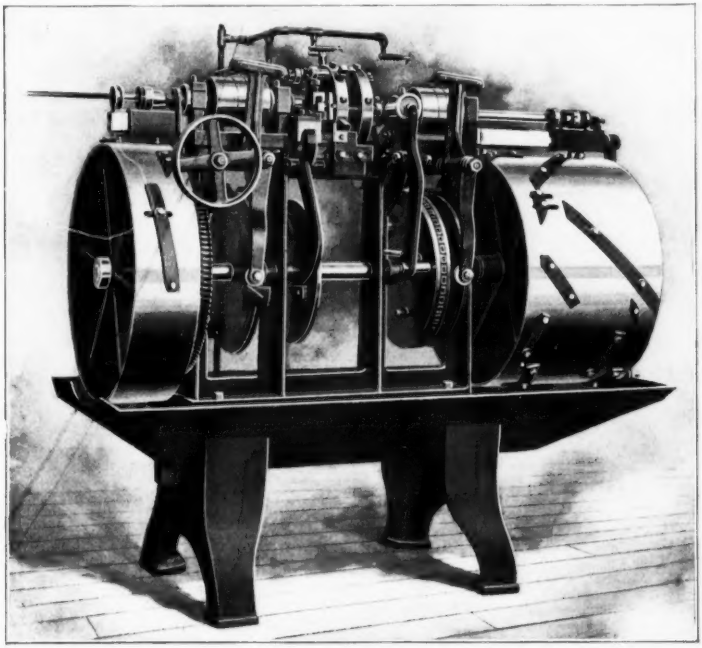
SCREW MACHINE, 1-INCH CHUCK CAPACITY, 5¼-INCHES WORKING LENGTH.

rectangular section could be screwed in any desired position, so as to constitute an endless succession of different cams, suited to produce any required movements of the turret machine members, at no cost beyond the small expenditure of time required to "set up" the cam strips on the cam cylinder. The importance of this form of cam was wholly overlooked by the patent attorney who prepared Spencer's ap-



A MONITOR LATHE FOR BRASS WORK.
With auto-chuck, wire feed, and chasing apparatus. Made by Windsor Machine Co.

plication for patent on the automatic screw machine, and so was never covered by any claim whatever. This universal cam was, and is, however, one of the most important of all the inventions ever made in metal-cutting machines, and deserves to rank with Maudslay's slide rest and Stone's adaptation of the turret to the general requirements of machine-part production.

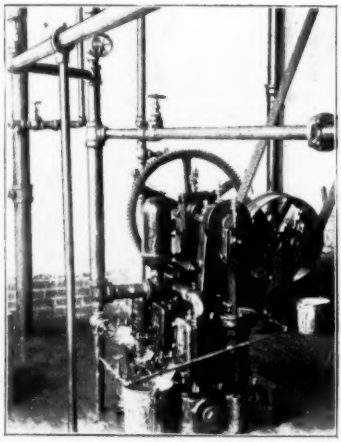


SPENCER DOUBLE-TURRET AUTOMATIC SCREW MACHINE, SHOWING THE "PROTEAN CAM."

The double-turret machine has a forward and a rear turret, acting in conjunction with a primary and a secondary spindle. Thus two series of operations may be simultaneously performed on opposite ends of the same piece by two independent, complete sets of tools.

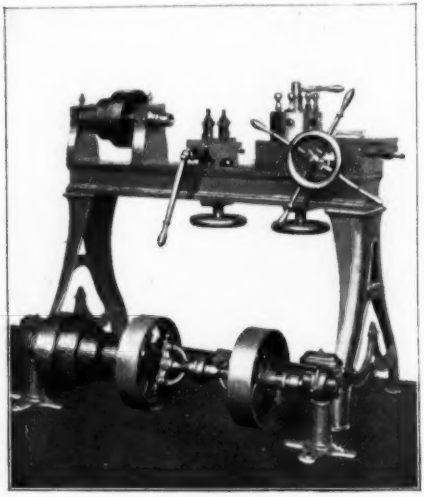
Here then, at last, three-quarters of a century after Maudslay had shown that a lathe could hold and guide its own cutting tools better than any workman could hold them, Spencer produced the lathe which could take a bar of stock and work it up into small machine parts wholly without human intervention. Parkhurst, of Middletown, Connecticut, had in the Pratt & Whitney shops applied the hand-operated push collet to feeding and holding round rods in the

turret machine live spindle. Spencer took the draw-back collet for the same purpose, both the draw-back collet and the push collet for holding work in rotating tool spindles being before known. With the collet for holding the bar of stock in the live spindle, and the protean cam, the full-automatic screw machine became a universal tool, of as general application to the production of machine parts as the lathe, planer, or drilling machine, and made more, better, and cheaper work than was ever before possible. This was seemingly the end of the possibilities of machine production in small work. The weight of a long bar of stock prevents the turret machine from working bars more than four or five inches in diameter. The bars are never quite straight, and never run true when gripped by the collet in the live spindle, and a bar, say 4 inches in diameter and 15 feet long, when held in a live spindle not more than, say, 36 inches long, and gripped at the extreme end only, cannot be so supported as to revolve without an unfavorable influence on the accuracy of the work produced. Again, large turret lathes are ex-



OIL-CIRCULATING PUMP, LOZIER SHOPS.

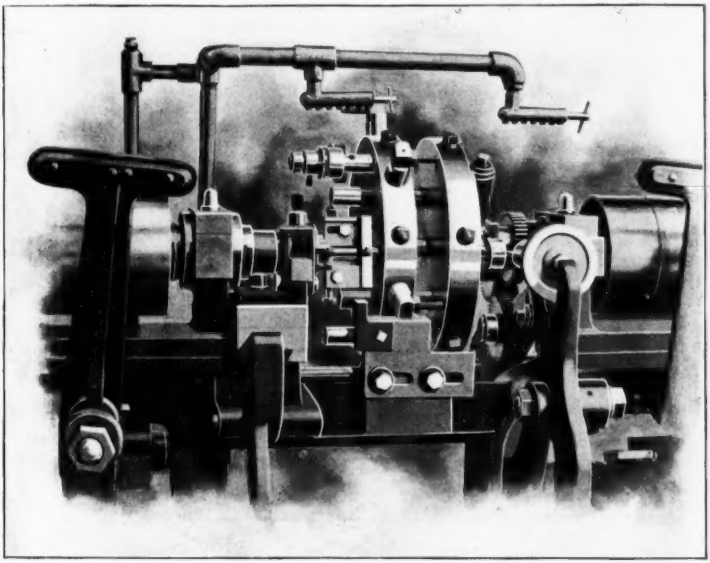
An automatic auxiliary to the automatic screw machine. The entire shops are piped from the pumps, the used oil being taken from the machines, passed through an oil-cleaning machine, and returned for use. The oil circuit is continuous, and needs no manual intervention.



AN EARLY MONITOR MACHINE

Jones & Lamson, about 1881.

tremely expensive, and there is but a very small demand comparatively for round pieces over two or three inches in diameter in machine construction. These considerations must, so far as can now be seen, limit to less than 5 inches, and perhaps to less than 4 inches, the diameter of long bars to be worked up in the turret machine. Bars of



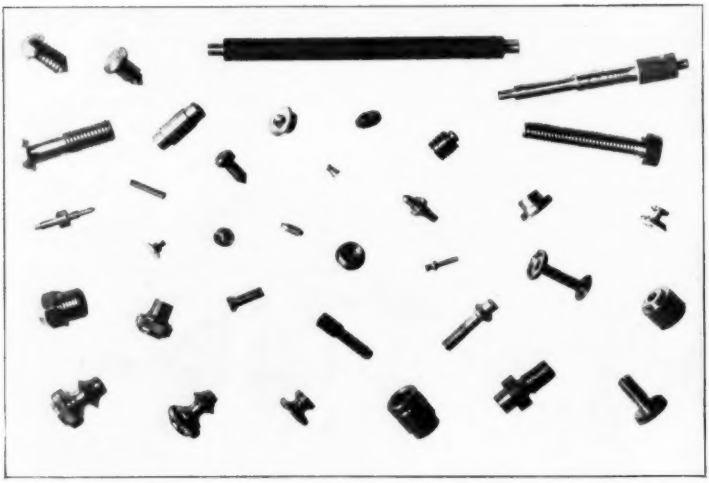
ENLARGED VIEW OF THE DOUBLE TURRET AND SPINDLES.

The primary spindle carries the rod, which is operated upon by the tools in the forward turret; the secondary spindle carries the detached and partially completed piece, while the work upon it is completed by the tool in the rear turret. All operations, including ejection of the finished piece, are automatic Made by the Spencer Automatic Machine-Screw Co.

3½ inches diameter are the largest known to me as being worked in a turret machine, and I believe only one machine of this size is in existence.

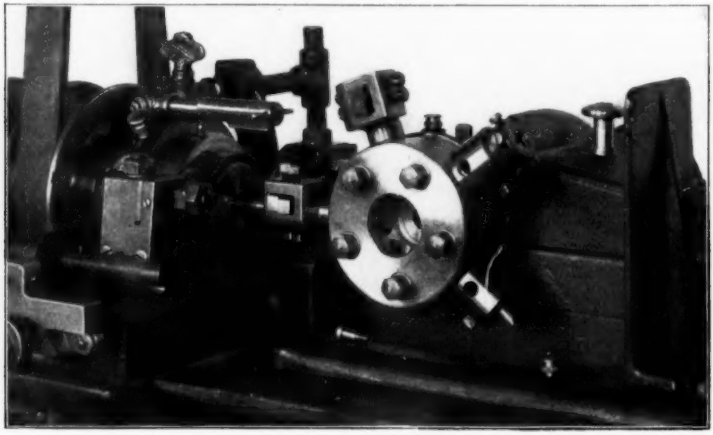
The full-automatic turret machine was not, however, the limit of the possibilities of the metal-working lathe when viewed by a mind as comprehensive as Spencer's. His final inventions in turret machines reach the superlative degree of the double-turret screw machine, which has vastly greater powers than the single-turret machine.

The single-turret lathe can do everything that the most skillful turner can do to a piece chucked in the live spindle and running "in

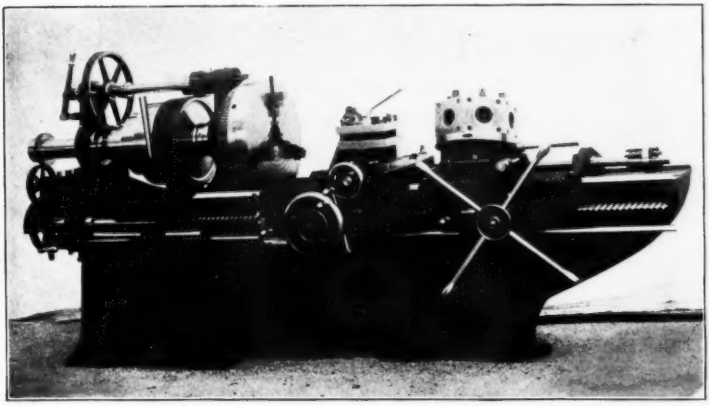


MORE EXAMPLES OF THE RANGE OF WORK POSSIBLE ON THE AUTOMATIC SCREW MACHINE.
The pieces photographed above are the products of the machine shown below.

the air," as the shop expression has it. A piece of metal so held has its sides and outer end fully exposed, and these may be given any desired shape, without removing the work from the chuck. But many pieces



TOOLS IN POSITION FOR MAKING A SHOULDERED SCREW.
One of the finished screws is seen immediately under the chuck. The machine is one of Brown & Sharpe's "No. 00."

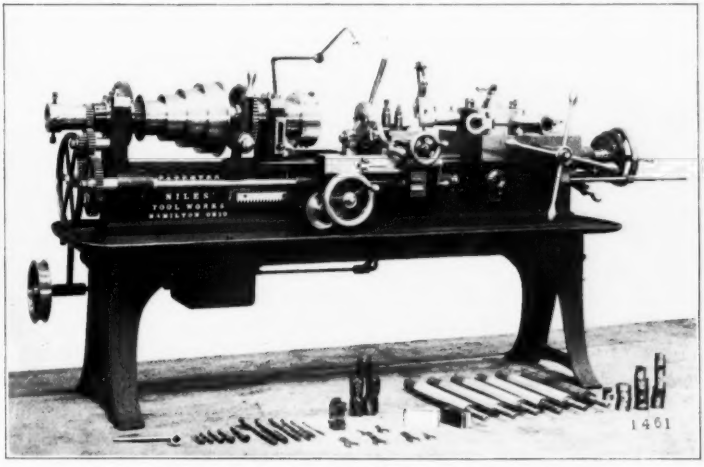


A TURRET MACHINE FOR A WIDE RANGE OF WORK.

The succeeding issue will show several views of special tools fitted in the machine for finishing certain parts of machinery. Made by the Gisholt Machine Co.

require cuts to be made on the third surface, which is not accessible, being inside of the chuck of the live spindle or otherwise supporting the piece as it is worked.

To meet this case, Spencer introduced a second chucking spindle,



SCREW MACHINE FOR BOLTS FROM ⅜-INCH TO 1-INCH DIAMETER.

The turret revolves and locks automatically, the point at which the revolution occurs being adjustable and indicated by a gauge at the front of the turret slide.
Made by Niles Tool Works.

PRODUCTS OF THE FLAT-TURRET LATHE.

opposed to the live spindle, and capable of moving towards the live spindle and grasping a piece of partly completed work while yet held by the live spindle, and, when the work is released from the live spindle, this second chuck-carrying spindle is made to move backward away from the live spindle, carrying the incompleted piece to a new location, where it can be fully completed by tools carried in the double turret. Thus, a screw which requires a slotted head may have its thread, body, and head formed while chucked in the live spindle; the second spindle comes forward and surrounds and grasps the screw up to the head, and as soon as the screw is cut off from the bar held in the live spindle, the second spindle travels backward and stops in such a position that tools carried by the second turret can shave and slot the screw head, or bore a cross hole through it and drill and tap the head to form a combined screw and binding post for electrical work, for example. Thus it produces, completed on a wholly-automatic machine, pieces which could only be made by two, three, or four operations on as many different machines by the best practice known before Spencer's magnificent inventions, which have great powers of cost reduction coupled with the surprising simplicity of construction which is the hall-mark of genius.

WORKS MANAGEMENT FOR THE MAXIMUM OF PRODUCTION.

By J. Slater Lewis.

II.—THE LABOUR FACTOR IN THE INTENSIFICATION OF OUTPUT.

ALL practicable methods for the reduction of cost resolve themselves ultimately into methods of intensifying production. There are several directions in which this aim may be pursued. The great factors of production are manual skill and dexterity, intelligence in inventing and applying special devices for facilitating the handling of work, efficiency of the machines employed, the relationship which these elements bear to one another—viz., the organisation or environment amidst which they function—and, last but not least, design.

To intensify production—that is, to increase the output, considered per working period of time, without increase of plant—we may seek to modify any or all of these five factors. We may stimulate labour, by extra reward, to a greater average of exertion; we may foster and encourage the minor inventive faculties of all engaged in the work, officials and workmen alike, and lead them to offer suggestions, each perhaps of no great importance in itself, but capable in the aggregate of influencing production in a favourable sense; we may give close attention, and be prepared to give a thorough and exhaustive trial, to new types of machinery, particularly of the modern class of "exact" partly-automatic machines; we may overhaul, or, better still, recast our methods of administration in the manner reviewed in the first article of this series; and, finally, we may scrutinise every detail of our standard designs to see whether they are in all respects arranged for manufacture under the latest and best conditions.

The question of the stimulation and reward of labour is a wide one—perhaps the widest and most difficult of all. I do not propose here to raise the vexed question of trades unionism, either in the way of justifying its aims or of criticising its methods; I propose to deal, rather, with the concrete details of methods of payment for work done. The simplest and oldest of all such methods is the purchase of service by time. Its obvious disadvantage is that there is no constant

The ruling idea of modern industrial economy is the avoidance of waste, either of effort or material. And the mechanical world sees, with ever increasing clearness, that effort which fails to produce the maximum possible effect is to that extent wasted. Mr. Lewis

relation between money expended and work performed. In the simplest kinds of labour, mere muscular exertion for instance, this introduces already an element of uncertainty, although the *average* work of a man may be fairly well known. But in all operations into which skill, and to a still greater extent intelligence, enter, the defect of this method of remuneration becomes patent and glaring. The relative intelligence of men cannot certainly be gauged and averaged as can their muscular activity, and even the ultimate degree of mere manipulative skill to which men may attain under the same opportunities varies within wide limits.

The future of any particular business, considered as an industrial unit, or of a whole industry regarded as a national unit, depends, however, upon the degree of effectiveness of output to which it can be evolved by the most skilful management. The more ineffective the methods of calling forth the best energies of labour, the shorter-lived will be the period of supremacy of that industry in the markets of the world. The question of the reward of labour becomes, therefore, a vital point when we look round on the rising industrial activity of other and younger nations, and realise that the alternative before us is either to match, and if possible surpass, them in intensification of productive output, or find ourselves, with each succeeding wave of slackness, and shrinkage in volume of business, less able to keep our men in work, and the commercial wolf from the door.

Whilst there is, and always will be to some extent, a description of work of which it would be most difficult to measure the due economic reward save by the indirect method of measuring and paying for the actual time occupied on it, yet, as will be more fully enlarged on under the head of "specialisation," this particular class tends *relatively* to diminish. The ordinary operations of the manufacturing engineer do, as a matter of practice, tend towards repetitive work, and it is, therefore, necessary to consider this class more especially.

To abandon the system of payment by time and to substitute payment for work performed is a considerable economic advance, alike from the point of view of the employer and the workman. To the former it means, under the most inelastic system, at least the substitution of a known for an unknown element in cost. To the latter it opens up, for the first time, the possibility of realising, even though only upon a small scale, the satisfactions of individual enterprise which otherwise do not exist for him. But even where we agree that

and Sir Benjamin Browne, in pointing the way to better management, and Mr Roland, in exhibiting more effective mechanical appliances, address the engineering world upon the most vital questions now demanding its thought and study. THE EDITORS.

the workman's reward shall be proportional to his work, this reward may be made immediate, definite, and personal, or dependent on the co-öperation of numbers, and realised only as a share of a general result. The former of these is exemplified by all systems of the "contract" or "piecework" variety, and the latter by the so-called "profit-sharing" methods. However useful these last for the development of *esprit de corps* in certain special kinds of business where the volume of trade, and consequently the statistics of employment, are fairly constant, it cannot be said that they fulfil the vital condition of an immediate and personal spur to the intelligence of the individual operative. Of these two classes of remuneration by results we must look rather to the piecework than the profit-sharing variety to produce direct and immediate reactions.

It cannot be pretended, however, that the piecework system, as usually employed, commends itself as a satisfactory, still less as a final, solution of the problem. We obtain, it is true, an immediate definition and limitation of cost, coupled with a strong and direct inducement for the employee to exert his best endeavours to increase and intensify production. At least, this is the theory; but in practice it is a true statement of the result only within very narrow limits. The defect of the method is, that when once the workman has begun to derive a profit from the transaction, the employer has no *direct* interest in his further exertions, but only the indirect advantage of a stationary labour-cost coupled with a greater intensity of output. The general result of this is, of course, well known and understood. There inevitably comes a time—if the workman continues to improve in skill, or to give evidence of a continuous and successful application of intelligence to his work—when the gains of the workman appear excessive compared with his former earnings as a mere supplier of labour by the hour. The employer would be more than human who did not, at this stage, ask himself the question, "Have I not made a mistake in fixing prices?" When this question is answered affirmatively, a reduction of rates inevitably follows. The suzerain power insists on remodeling the convention, and the result is frequently—not peace, but soreness. Of course, where much piecework is in vogue, the trouble does not necessarily arise with as much frequency as might be expected, for a very good reason. As soon as the workman finds himself approaching the point at which his extra earnings tend to rise beyond the limit at which the traditions of the shop teach him the reduction may be expected, his efforts slacken. He makes no endeavour either to improve in skill, or to trouble himself about little

tricks for the better management and handling of his job. His interest for the future is barred, and the net result amounts to this—that he has adopted a somewhat greater intensity of production, and receives a somewhat greater constant remuneration than when he was on hourly wages.

That there is a gain, both to man and employer, is obvious; but that it is a slight and limited gain is also obvious. Abstractly considered, the method is remarkable no less for what it wastes than for what it effects. From an examination of its defects we are enabled to formulate the conditions which must be fulfilled by a more satisfactory method. We require: (1) a minimum standard of remuneration based on the average attainments of hourly labour; (2) free and full incentive to the workman to improve upon this average, not merely up to a certain arbitrary stage of improvement, but without limit; (3) participation of interests between employer and workman in this improvement not merely in its early stages, but to the ultimate extent to which the intensification of output and consequent reduction of costs per piece can be carried, either by constantly augmenting manipulative skill, or by a series of small improvements in method. A theoretically perfect system of remuneration should not involve the constant comparison between the piecework earnings of the exceptionally clever or skilful workman, and his former earnings when neither exceptional skill or cleverness were asked for, nor sought to be rewarded.

It may be objected that this theoretical perfection is actually realised to the full by the piecework system, if only we assume that rates shall never be cut. This is, of course, true; but it is not the whole truth. The element of participation by the employer in the direct reduction of labour-cost is entirely wanting, and that such participation is essential and just can be seen readily enough. If it be true that the actual reduction is wholly due to the efforts of skill or of intelligence exerted by the workman, it is equally true that the opportunity for such exertion is provided by the enterprise, and perfection of technical and business organisation of the firm.

It is the absence of provision for reward of the employer's foresight and organisation, collaterally with remuneration of the workman's skill and intelligence, that is the fundamental weakness of the piecework system. The "big figures" go to swell the workman's earnings alone, and the employer feels that he must do something to preserve equilibrium. The only thing he can do is to cut rates. But this is like killing the goose that lays the golden eggs. The excessive

earnings of the workman are certainly pruned away, but so, unfortunately, is his alertness to profit by every opportunity to intensify production. This is a moral effect that cannot be scheduled, or reduced to graphic form. On the other hand, there is no reason to suppose that the 25 per cent. or 30 per cent. advantage in intensification, which is the normal result of the adoption of pieceworking, is a natural limit of productiveness. Even though it be assumed that this represents the maximum development of more manipulative skill likely to result from any possible incentive that can be offered, no such assumption can be maintained as regards that class of work in which the application of wits can be made to influence the quantity of output. Limits cannot be set to the workings of intelligence, and it is certainly to the employer's interest to foster, and not to throw a damper on, such efforts. Yet the adoption of an arbitrary standard of maximum earnings cannot have any other influence than this. And while the employer has only an indirect advantage in the greater rapidity of production, and does not feel the benefit in reduced labour-cost per piece, when once a price for the work has been agreed upon, it is evident that he cannot afford to look with equanimity upon profits, which his organisation and foresight have rendered possible, going entirely into the pocket of one party to the bargain.

From these considerations the conclusion is forced upon us that, although pieceworking is a decided advance, other things being equal, over hour-wages, in realising a higher intensity of production, yet it does not in practice do as much good, as, at first sight, it seems to promise. It opens, but does not keep open, the door to that individual development of the skill and intelligence of the workman that we commenced by postulating as a desirable feature. And its failure to do this is because such development can only take place at the expense of the employer, and we are not able to bring into the calculations the share of the latter in producing the total result.

That these unsatisfactory features have tended to discredit the methods of payment by results cannot be doubted. From the workman's point of view, no less than from the employer's, there is dissatisfaction with a method that renders something short of absolute justice to either party; the workman is no less keen to look with suspicion on a periodical readjustment of rates than the employer is to question the expediency of permitting large balances to mount up in constantly increasing ratio. These admitted deficiencies have of late years, and particularly in the United States, led to attempts to remodel the fundamental basis of contract work, and to bring about a

real identity of interests between employer and workman in the direction of uninterruptedly increasing the intensity of production, to the mutual benefit of both parties.

The essential peculiarity of this method is that a resultant saving of production-cost is divided between the workman and the employer, the proportion between the two shares being variable according to the special conditions of the work. It is manifest that, were the piecework system really efficient in calling out the best energies of the workman—not merely up to the "critical" rate (by which is meant the rate at which, in any particular shop, further reduction in cost would lead to a revision of prices), but beyond it to the ultimate practical possibility—the premium system would scarcely be a serious rival as regards popularity with employees, since, instead of the whole saving going to the workman, only a portion, depending upon the ratio fixed on, goes to him. But in the few cases in which evidence is available of the working of this method, the actual result seems to be, what indeed may be expected from the considerations discussed above, that production cost does tend constantly to diminish. This is because the important feature of the newer method is not that the saving is divided between employer and workman, but that no artificial barrier, no "critical rate" of earnings looms in front of the latter to dampen his activity and lead him to slacken his energies.

At the same time, the significance of a high rate of earnings by the workman is entirely changed. Of its satisfactory appearance to the man, nothing need of course be said; but it becomes also a satisfactory phenomenon to the employer. In fact, it is an index, not merely of increased intensity of output, but of actual reduction in direct cost per piece.

It would appear, therefore, that in the long run the premium system will tend to displace existing methods of remunerating labour. It has, of course, certain theoretical disadvantages which must be opposed to the benefits it offers. Its immediate incentive is not so strong, and it is, therefore, on this account perhaps more suitable for repetition work than for work recurring at comparatively distant intervals. The fundamental principle of the method—that rates once fixed are never to be cut, whilst conditions remain the same—will require very careful observance in order that the confidence of the workman may be won for it. And this principle may, in careless or unscrupulous hands, be made to clash with the necessity for revising the rates when alterations in design have taken place, or modifications of process have disturbed the original fixture. These are ele-

ments of danger peculiar to the system; because, *unless* the principle of permanent and unalterable rating is made and accepted in good faith by both sides, and so maintained, the premium method does not, in appearance at any rate, offer the same advantages to the workman as the older method. And its popularity would certainly be seriously shaken in any shop where alterations, under the special circumstances just mentioned, were made the excuse for reducing the workman's share in more than fair proportion.

Whilst upon the subject of the labour-element in production, something may be said as to the development of an *esprit de corps,* a tone, amongst the employees, leading them, or the progressive spirits among them, to feel that any expenditure of thought on their part, contributing to the welfare of the whole, will be appreciated and rewarded. The question is difficult, no doubt. The propounder of a suggestion naturally magnifies its importance and is a believer in its practicability. If it is ultimately accepted, in however modified a form, he is apt to assume to himself the whole glory, and to think himself unjustly treated if the reward is not proportional to his own valution of his services. But, as between the employee and the firm, the question is a simple one. It is the manner in which suggestions are commonly expected to reach the executive that is the most troublesome part of the problem. To filter from the workman to leading hand, foreman, and departmental manager is not only a long process but may easily be a stifling one. It is of those immediately above or under him that a man naturally feels the most jealousy. To snub the aspirations of a subordinate is too often a pleasurable exercise, and a man who has once received a rebuff of this kind is likely to keep his hints to himself on future occasions.

In certain kinds of business, and particularly where changes of methods are creeping in amidst an old-established organisation, it may pay to keep an open ear for this class of prompting. In many successful works, particularly in the United States, a generous policy has proved to be of demonstrated value. It is well, therefore, to consider whether, amongst other methods of increasing output, an organised plan of receiving and considering suggestions from all and sundry may not have an established place. A large percentage of these will, no doubt, but poorly repay the attention given to them. It becomes a matter of practical experience to determine whether, in any particular business, the gain outweighs the trouble. In any case, direct submission of all suggestions to the responsible management should be arranged for.

Closely connected with the subject of the living element in production is that of a well considered scheme of subordination, including every executive official in the establishment. A clash of authorities is one of the most potent factors of waste, delay and demoralisation, and evidences of it should be closely watched for with a view to tactful but immediate remedy. The duties and obligations of every class of official should form part of a carefully considered scheme, and when the whole has been decided, made the subject of a graphic chart; each person concerned should be provided with a written or printed schedule of duties. Nor is this of itself sufficient. Developments will arise from time to time, introducing new features not provided for in the original scheme. These should also be charted and form the subject of additional instructions reduced to writing. In great organisations like those of the post office and the railway and telephone companies, this method finds its fullest development; but even in comparatively small businesses, as soon as they become large enough to adopt the departmental system of organisation, the benefit of such a plan of controlling and regulating the less important members of the executive will speedily be felt, if judiciously and thoughtfuly arranged in the first instance. For those whose duties are matters of comparatively unintelligent routine, the introduction of timetables of duties to be performed at certain hours, or on certain days, will also be of considerable assistance to the smooth working of system—if care be taken, particularly at the introduction of such a method of control, to see that the duties so detailed are carried out in the manner prescribed.

Another point of importance in connection with the *personnel* of large departmentalised establishments is that of adopting some method of periodically bringing together the heads of departments, and reviewing all the more important work in progress, item by item, each department stating the causes of delay if any, and instruction being noted as to expediting it. In my own practice I term this a "conference," and in connection with detailed notes, preserved from one conference to another, have found it of considerable assistance.

In my next paper I shall consider the question of intensification of output from its more technical side. The problem of new processes, the introduction of automatic machines, and considerations affecting the profitable introduction of specialised machinery will be first considered, and after this the larger problems of design as affected by the modern tendency to "manufacture" rather than "make."

In Mr. Slater Lewis's article in THE ENGINEERING MAGAZINE for October, foot of p. 61, "an additional 30 per cent." should read "an additional 70 per cent."

ELECTRICITY FOR THE OPERATION OF AUXILIARY MACHINERY ON WAR-SHIPS.

By Lieut. J. K. Robison.

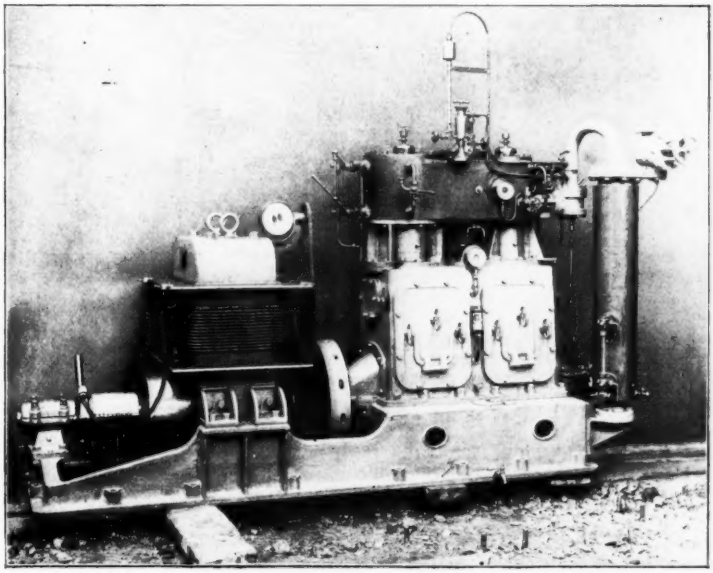
THE article in the preceding issue of this Magazine stated, necessarily in an extremely concise way, the conditions of gross waste of steam in auxiliary machinery for war-ships, as they existed some five years ago, and the character of the efforts that have been made to reduce the losses in the auxiliary machinery, together with the degree of success of these efforts.

The good results obtained in central-station practice on shore, in the matter of steam economy in the generation of electricity, naturally lead one to suppose that similar results should be obtained on board ships. Unfortunately, tests which have so far been made of the steam consumption of dynamo engines, actually installed on ships by the furnishers of electrical supplies, show anything but a good economy. The steam used per indicated horse power has varied from 55 to considerably over 100 pounds per i.h.p. per hour. It is hoped that the latest and best type of dynamo engines, as furnished by the electrical manufacturers, may have a steam consumption not exceeding 30 pounds per i.h.p. per hour. Even this would not be particularly good; but, however disappointing the results thus far obtained from dynamo engines, the issue is not affected. Of course, it would never pay to extend the use of electricity if it be impossible to better the economies indicated above, but the study of the conditions by competent engine designers and builders is bound to lead to economical engines, even though the units be small. Progress in this particular, even if no other advance be made, will involve a considerable reduction in the amount of steam consumption by the auxiliary machinery. It will probably not be long before flat valves are used on low-pressure cylinders of the dynamo engines, and the gross waste from leakage which exists at present is bound to be materially reduced. The establishment of a central power station must certainly lead to an increase in

the economy of steam consumption. The units as now installed in United States naval vessels are none of more than 50 K. W. capacity. I think it is fair to assume that, even for the light type of engine which is sure to be required on men-of-war, a steam consumption as low as 20 pounds per i.h.p. per hour can be obtained if the exhaust steam be taken to the condenser, and if the exhaust from the dynamo engines be taken to a feed heater the steam consumption should not rise above 26 pounds per i.h.p. per hour. In considering whether or not the exhaust from the generating engines of a central electric plant should be led direct to the condenser or to a feed heater, it is proper to consider the relative economy which would be achieved by the two systems. An increase of 30 per cent. in the steam consumption of the generating engines is pretty certain to follow their conversion to non-condensing engines. If the exhaust from the generating engines be taken to the feed heater, the gain in the total economy of operation of the entire machinery plant of the ship, as has already been stated, is about 9 per cent. The question, then, as to whether condensing or non-condensing engines should be used for the generating plant in the central station on board ship should depend upon whether or not 30 per cent. of the steam used by the generating plant is more or less than 9 per cent. of the total steam consumption. Of course, unless the system is very much worse than we have any reason to expect, it would pay to operate an auxiliary feed heater with the exhaust from the generating engines, which should be non-condensing.

One point upon which the success or failure of electricity on ship-board depends is the economy of conversion of power from the steam engine driving the generating set to effective power on the motor shaft. This is a question which has been answered in a variety of ways. Upon the correct answer depends in large measure the success of an electric installation. Sylvanus Thompson has given figures averaging about 52 per cent., as the efficiency of conversion of mechanical work performed on the generator to mechanical work delivered by the motor. This with average line losses and fairly efficient electrical machinery operating under normal conditions. Experience in the navy has indicated that about 50 per cent. of the i.h.p. in the engine generators is transformed into useful work done by the motors. The experience of large commercial users of electricity shows that the efficiency of conversion of power varies from 40 to 60 per cent., depending largely upon the line losses. Mr. S. Dana Greene, of the General Electric Company, in a recent paper, has stated that the total efficiency of an electrical system on board ship may be as

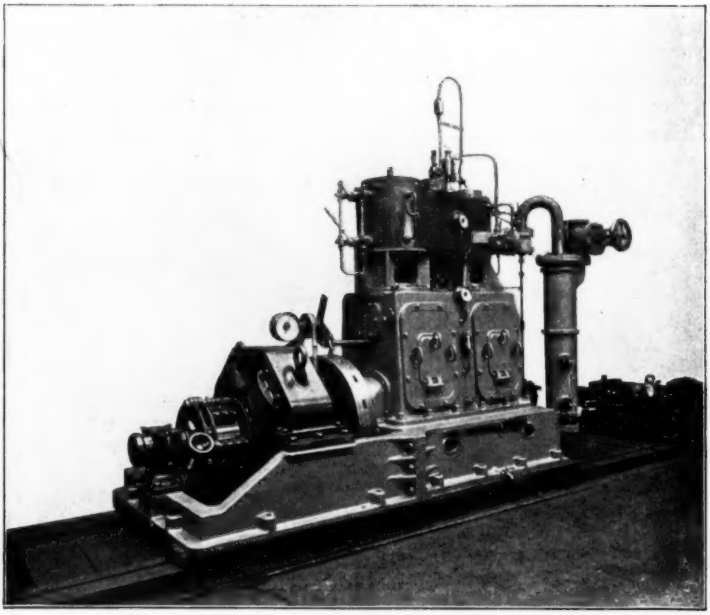
high as 65 or 66 per cent. I think it will be fair to assume an average efficiency of conversion equal to about 59 per cent., as follows: efficiency of generating engine, 93 per cent.; efficiency of generator, 86 per cent.; line efficiency, 95 per cent.; motor efficiency, 78 per cent. This assumes that the commutators are kept in good condition at all times. Experience in the navy shows that this will not be the case; but I believe that if electrical apparatus is installed on a large scale on men-of-war it will be properly attended to. It is assumed further



ENCLOSED TYPE OF COMPOUND ENGINE ATTACHED TO TWO-POLE DYNAMO.
The British Admiralty have lately adopted enclosed engines and dynamos, giving up the older type. The machine illustrated is by E. Scott & Mountain.

that the efficiency of conversion of power from the motor shaft to the auxiliary machinery is the same for the electric motor as for the steam engine. In some cases, such as a centrifugal blower for example, this assumption is unfair to the electric motor. In other cases, such as a steam pump or an ice machine, the efficiency of a steam engine is considerably greater than that of the gearing attached to the electric motor. On the whole, I think the figure given, 59 per cent., not far from correct.

Probably the figures given above as to generator and motor

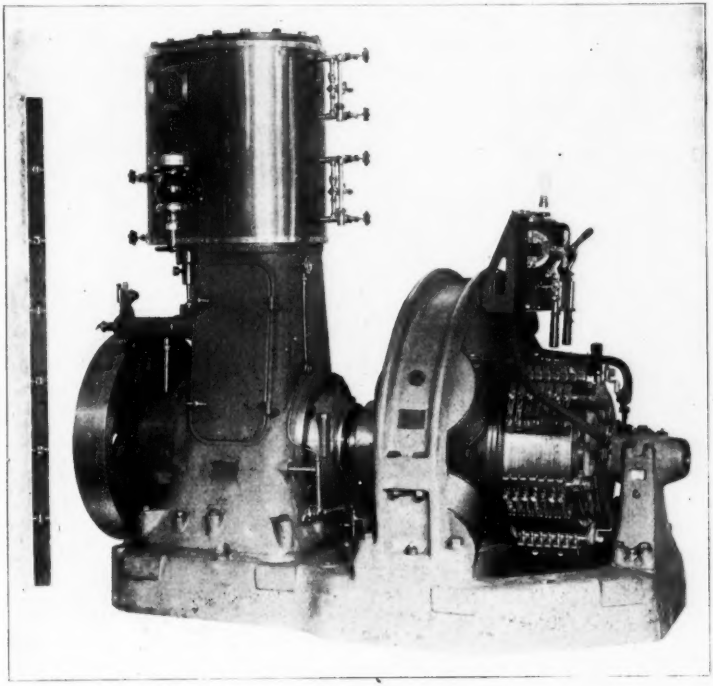


ENCLOSED COMPOUND ENGINE ATTACHED TO A FOUR-POLE DYNAMO.
Latest type of marine installation built for the Admiralty by E. Scott & Mountain.

efficiency will be considered low. I think, however, that when the large reserve of power required in the generator is taken into account, and when the variable loads and speeds of the motors are duly considered, the above figures will not be found to be too low. Roughly, it will take 5 i.h.p. in the engine driving the generating set to secure 3 h.p. on the motor shaft. If the steam consumption of the engine driving the generating set be taken at 26 pounds per i.h.p., the use of an electric installation would involve the equivalent of using about 44 pounds of steam per i.h.p. in the steam-operated auxiliary machinery. This is a reduction of 35 per cent. below the amount required by the most modern steam auxiliaries. If the auxiliaries now installed use 18 per cent. of the total steam, it would require but 12 per cent. to operate them by electricity.

This result is almost ideal. There will probably be considerably less condensation of steam in a central electric plant than there is among the widely scattered steam auxiliaries of a modern ship. While tests of the amount of exhaust steam at atmospheric pressure

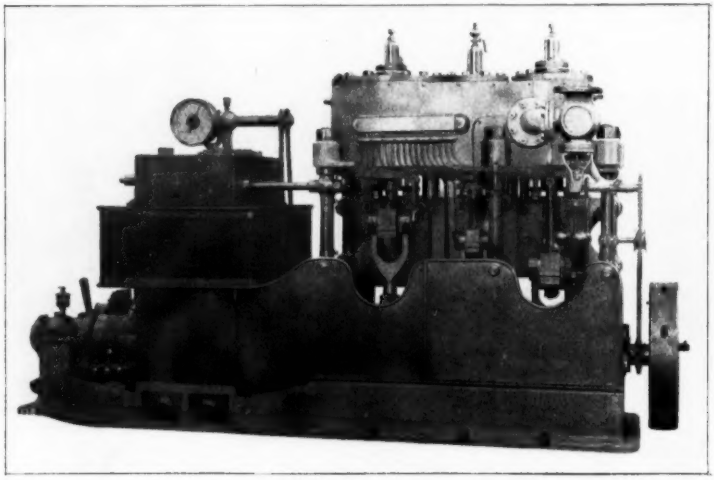
that can be usefully used in an evaporating plant or in a feed heater show that this may rise to 17 per cent., I think that the decrease in the amount of water of condensation in the exhaust steam from the electric engines may possibly decrease this figure to 15 per cent. On that account it seems to me that all of the gain of the electric system down to 15 per cent. should properly be credited to it, and that the use of electrically-operated auxiliary machinery will involve an increase of the potential value of each pound of coal on board a war-ship certainly of as much as 3 per cent. Further, the steam consumption of the electric auxiliaries has been shown to have been reduced to almost exactly that figure which will allow the condensation of all the exhaust steam from the generating engines in a feed-water heater. This is such a gain in simplicity that it is bound to lead to a gain in economy. At any rate, 40 per cent. of the difference between 12 per cent.



A NAVAL AUXILIARY GENERATING SET.
Made by the General Electric Company.

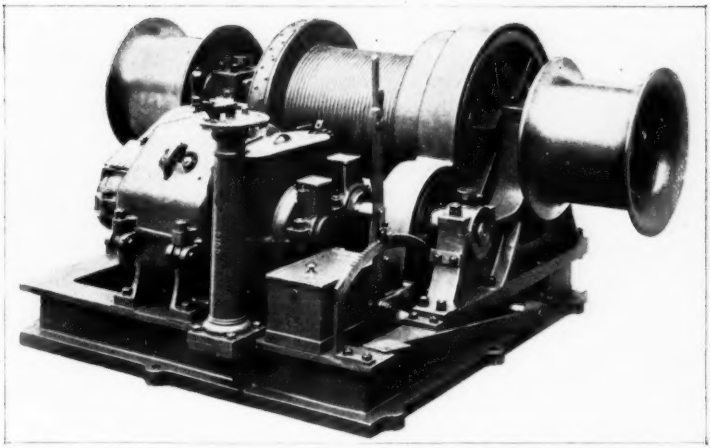
and 15 per cent. will be a saving, owing to the fact that more steam is used in the evaporating plant if the pressure be reduced to that of the auxiliary exhaust. The saving due to the use of electricity must then be 4.2 per cent. at least, with the possibility that this saving will be as great as 6 per cent., which is the maximum possible gain. It is proper to mention here that the above economy can only be attained if the electric generating engines are made of the most economical type, with a steam consumption when non-condensing not exceeding 26 pounds of steam per i.h.p. per hour.

Let us see if this is one of those apparent economies which are real losses. Does or does not the maximum possible gain of 6 per cent. following the introduction of electric auxiliaries, exceed the price we have to pay for it in increased weight? Unfortunately the increase in weight is considerably greater than the gain. Taking the case of large battle-ships of the latest type, the total power of the auxiliary machinery is at least 1,500 i.h.p. The approximate weight of this machinery is 150,000 pounds, or 100 pounds to the indicated horse power. If electric motors are used to drive the auxiliaries, it will be necessary, in order to get the requisite torque at the highest speeds, to install motors of 1.5 times the rated horse power that would be required if steam auxiliaries were used, thus requiring a total motor



OPEN TYPE ELECTRIC-LIGHT ENGINE AND DYNAMO

Supplied to Chilian battle-ship Blanco Encalada by E. Scott & Mountain



ELECTRIC-DRIVEN COMPOUND DECK WINCH.

25 h. p., 160 volts, 150 amperes, 320 r. p. m. Shunt wound. Made by the General Electric Co.

capacity of about 2,250 h.p. The weight of the motors per horse power may be taken as about that of the steam machinery. If the motors were large the weight would probably be less; but the motors required for the operation of the auxiliaries on board ship would generally be small ones. The increase in weight due to the use of electric motors will, therefore, be about 35 tons.

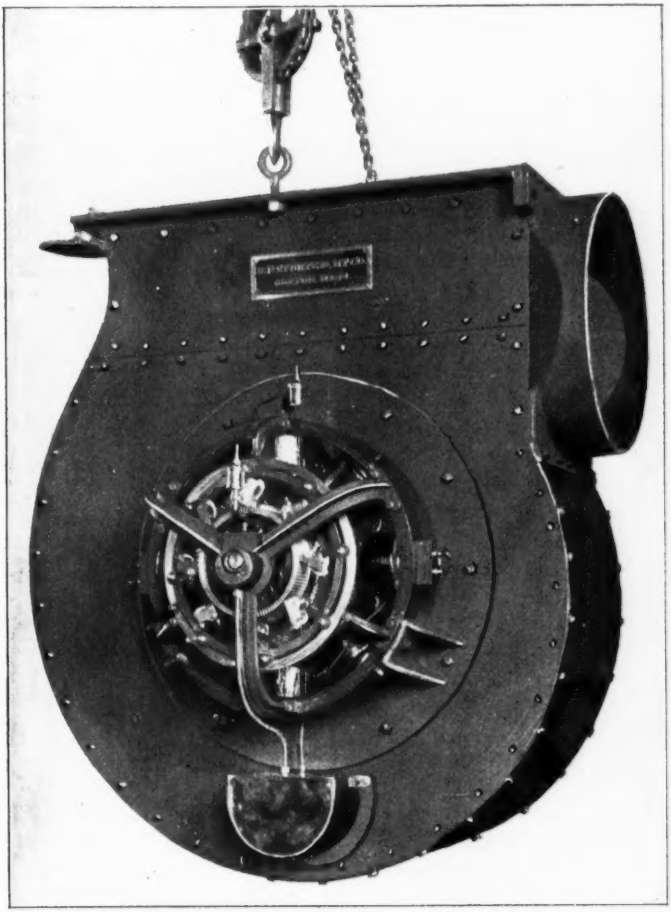
The principal increase in weight due to the use of electric auxiliaries is in the generating room, and here comes the question as to the amount of power required in the generating plant. While the total power of the auxiliary machinery on board a battle-ship is 1,500 h.p., the average power of the auxiliary machinery while the vessel is cruising at its most economical rate is only about 100 h.p., and the maximum power that is developed by the auxiliary machinery, which will be in time of battle with the vessel at full speed, is only about 700 h.p. This is because, during action, deck winches, anchor hoists, the ice machine, shop engine, and at least a part of the pumps will not be in use. Of course, all the forced-draft blowers, turret engines, ammunition hoists, steering engine, and a very large part of the pumps will be worked at full power. It may confidently be stated, however, that the maximum power of the auxiliaries will be about 700 h.p., with steam auxiliaries in use, or probably 1,000 if all the auxiliaries are electrically operated. The efficiency of the mechanical conversion of

the power in the generating engines to effective power delivered at the motor shaft has been found to be about 59 per cent. The development of 1,000 h.p. by the electric motors involves, therefore, the development of about 1,600 h.p. by the generating engines. The central electric station should, therefore, be of sufficient capacity to develop this power upon demand. This requires, say, five 250-K. W. generators, four of which would be necessary for the production of the maximum current required and the fifth would be used as a spare. The weight of the electric plant of 1,250 K. W. capacity (both generating engines and generators proper, with wiring and piping, being included), would be about 180 tons. The total weight of the electric apparatus would, therefore, be about 295 tons, as against about 85 tons for the steam-operated auxiliaries with their piping and connections. That is, the installation of a central electric station would involve multiplying the weight of the auxiliary system by 3½, if the generating plant be made of sufficient size to be capable of satisfying the maximum demand and if one spare unit be installed.

Some calculations as to the weight of the generating plant give lower figures than the foregoing for the weight of the electrical apparatus required. Mr. Dana Greene says that it would require only 2½ to 3 times as much weight as that of a steam plant. His figures are based upon the following assumptions: (1). There will be no increase in the weight of the motors beyond that of the steam engines now used as auxiliaries; (2). The efficiency of the mechanical conversion of power is taken at 66 2-3 per cent.; (3). The total size of the generating plant is taken at 1,050 K. W.'s, divided into units of 150 K. W.'s each.

It seems to me that the weight of the electric installation would be much more nearly 4 times than 2½ times as much as that of a steam system. If my premises are correct, the use of electrical installation involves an increase in weight of 210 tons. If the calculations of the more enthusiastic advocates of the electric system are correct, the use of electrically-operated auxiliary machinery involves a difference of but about 150 tons in the weight of the auxiliaries. In either case, the bunker capacity of our largest ships being 2,000 tons, the additional weight is considerably greater than the greatest possible gain of 6 per cent. One hundred and fifty tons is 7½ per cent. of the bunker capacity, while 210 tons is 10½ per cent. To increase the potential value of a ton of coal by 6 per cent., we will have to decrease the amount of coal by as much as 10 per cent. The net result is, of course, disadvantageous as respects the steaming radius of the ship.

Therefore, inasmuch as the steaming radius is a vital factor, the introduction of an electric central station for the operation of all the auxiliaries of war-ships does not seem to me to be advisable. The use of

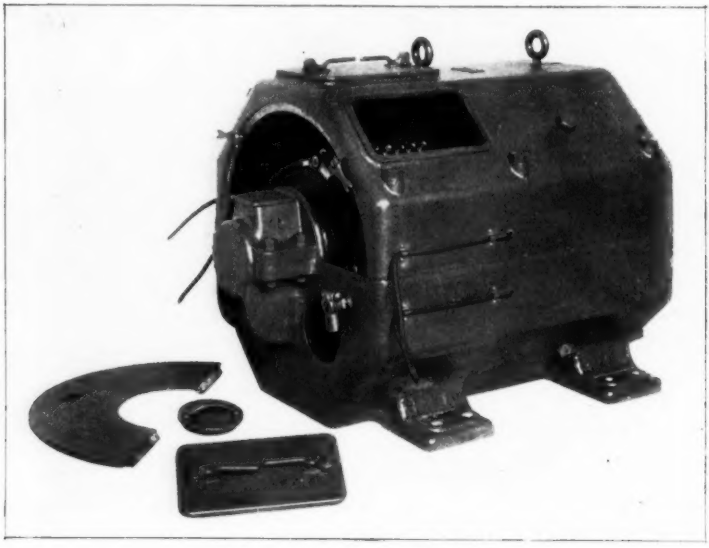


ELECTRIC-DRIVEN STURTEVANT FAN FOR SHIP VENTILATION.

the best electric apparatus for operating the auxiliary machinery involves a loss of about 5 per cent. in the ship's radius of action. Indeed, the above conclusion follows the use of electric apparatus considerably better than any that has yet been fitted in a ship. A loss in

coal endurance follows also the adoption of the premises of the most ardent advocates of the electric system. Electric auxiliaries cannot, therefore, pay until considerable progress has been made in the design of electric apparatus.

The enormous value of coal endurance is shown in such instances as that of the "Newark," disabled completely 300 miles north of the Straits of Magellan for lack of sufficient coal to complete the 2,500-mile passage between Montevideo and Valparaiso. Ships are nearly always able to complete any trip they commence, and coaling stations are not generally far apart along any of the usually traveled lines of commerce. It was not very many years ago, however, that the steamer "Rio de Janeiro" was forced to turn back on her 3,500-mile trip between Honolulu and Yokohama. In this case the "Rio" only got back to port after burning some of the wooden fittings of her cabins. These failures serve very well to point the importance of a large coal

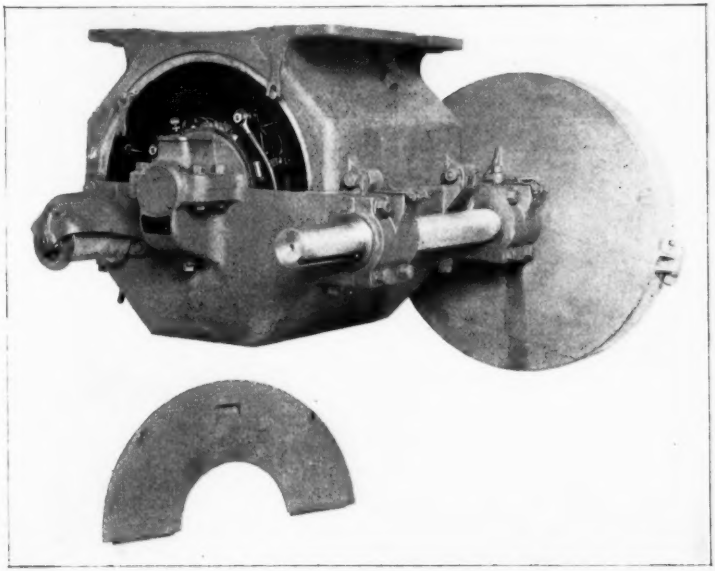


ELECTRIC TURRET-TURNING MOTOR.

50 h. p., 80 volts, 500 amperes, 400 r. p. m. Shunt wound. Made by the General Electric Co.

capacity for all ships, and particularly for men-of-war. In time of war a large number of coaling ports are closed to the belligerents and, by many nations at least, coal is declared contraband of war.

To justify the general use of electrically-operated auxiliaries on board ship, certain specific progress must be made in design. Probably satisfactory steering engines or anchor hoists have not yet been



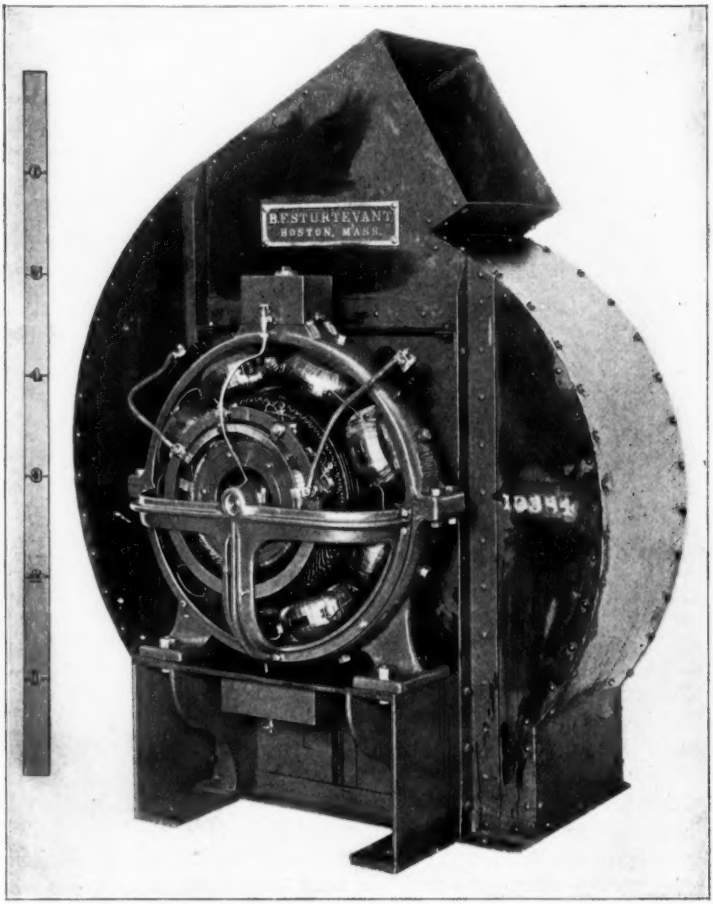
AN AMMUNITION-HOIST MOTOR.

20 h. p., 160 volts, 110 amperes, 350 r. p. m. Shunt wound. Made by the General Electric Co.

evolved, yet they certainly can be made and will be made as soon as it becomes necessary. I believe that the installation of electric machinery is carried considerably further on the Russian battle-ships building at the Cramps' than has yet been attempted in any American ship. It will be interesting to note the operation of this machinery in service. Elecrically-operated auxiliaries can readily be made of sufficient power not to be put out of order easily, and I think can be made to satisfy all the requirements of naval service. This involves some progress beyond the present position attained by the designer of electric motors. The auxiliary machinery aboard ship works with such a wide range of power and speed that electric motors, as at present designed, are not very efficient for average conditions.

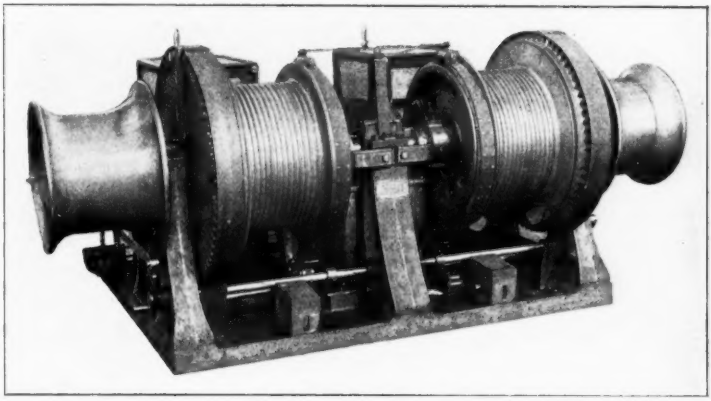
It would be a vast advantage if electric motors could be lightened; but the great loss involved in the use of electricity comes in the generating room. The principal advance that we may expect will prob-

ably be the adoption of an efficient turbine engine which will maintain a high rate of efficiency over a wide range of power. This will probably involve a decrease in the amount of steam used by the generating



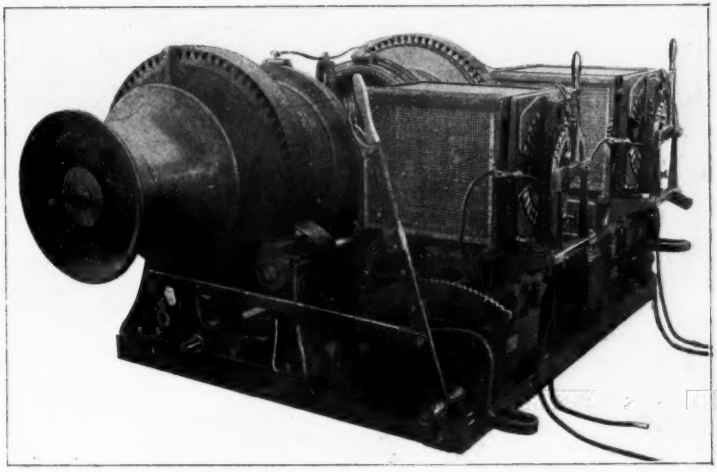
ELECTRIC MOTOR DIRECT-CONNECTED TO 50-INCH EXHAUSTER.
Made by the General Electric Co.

engines, and in that respect an increase in economy for the use of electricity. Further and chiefly, the adoption of turbine engines will reduce the weight of a generating set by, it is hoped, 40 to 50 per cent.



DOUBLE ELECTRICAL STEAM-SHIP HOIST FOR THE NORTH GERMAN LLOYD.

We may also confidently look forward to an increase in the efficiency of conversion of mechanical power. The efficiency of motors especially is being increased until to-day it has reached a figure that it would have been thought unreasonable to expect ten years ago. I think that we may hope for an increase in efficiency of conver-



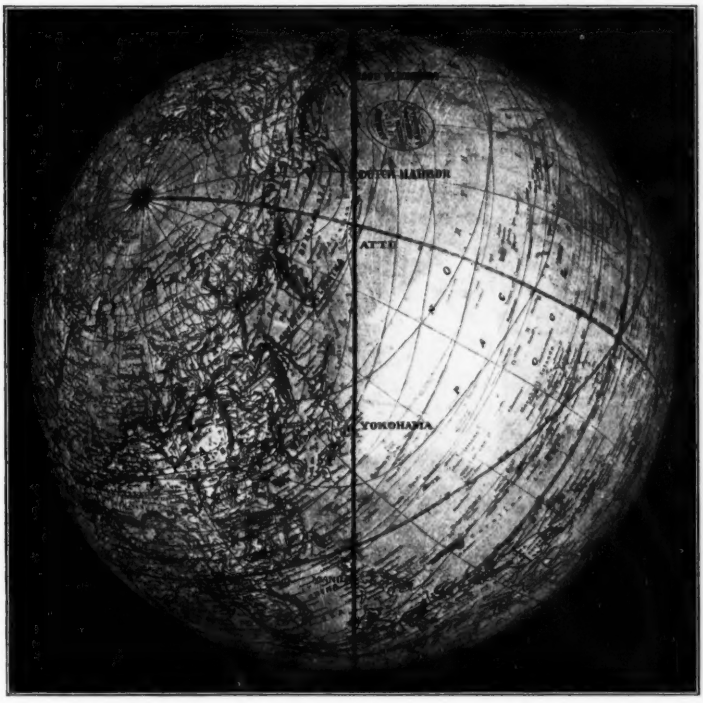
DOUBLE ELECTRICAL STEAM-SHIP HOIST.

Built for the North German Lloyd by the American Ship Windlass Co. Driven by two motors of 26 h. p. (actual) each. Can raise on each drum 2 240 lbs. at rate of 207 ft. per minute, or 6,720 lbs. at rate of 69 ft. per minute. Weighs 11 500 lbs.

sion of energy to, perhaps, as much as 70 per cent. If this can be achieved, and if the turbine engine is properly developed so as to be available for naval use, the adoption of electrically-operated auxiliary machinery would not involve an increase in weight exceeding 100 tons. The added weight will not then have so bad an effect upon the coal endurance, while the change to electrically-operated machinery may have such a beneficial effect upon the efficiency of the ship's auxiliaries, and of course upon the ship itself, that we may expect its adoption. Of course, it is more than possible that, by the time the electrical men offer a feasible solution to the problem, the manufacturers of the steam auxiliaries may have cut their consumption down to such a low figure as to eliminate all the gain due to the electric system. Prof. Elihu Thomson has shown us that it is possible to operate very small steam engines with a steam consumption less than 30 pounds per i.h.p. per hour. On the other hand advance in the design of auxiliaries may very possibly be made by the mechanical engineers themselves in, for instance, the form of a feed heater which will take steam from the receiver of the engine. If this can be properly developed, it will pay to use condensing engines for the generating sets and the consumption of the auxiliaries can be profitably reduced to a minimum.

I have given some reasons why it seems advisable to increase the size of the electric generating units. There are some reasons why this is difficult to accomplish, such as the difficulty of control of the turret machinery when not operated, as at present, by a separate generator for each turret. This progress in design must certainly come, however, before we can use electricity in a general way.

The whole question is one of economy. To-day electricity takes more than it returns, and that is why we are not justified in extending the use of electricity until the weights can be cut down materially.



A great circle—the shortest possible route across the Pacific.

THE PROPOSED PACIFIC CABLES.

By Harrington Emerson.

OCEAN cables are commercial enterprises to facilitate communication between friendly countries. Every one of the sixteen North Atlantic cables was laid to this end. It is folly to make an improbable war the governing condition for a new cable, but, as there is a disposition on both sides of the Atlantic to subordinate the prosaic and immense interests of peace to martial pomp, however remote, it may be worth while to point out that cables to neutral countries are much safer lines of communication in time of war than national lines. Notwithstanding strenuous efforts, the United States were not able to interrupt cable communication with Cuba, because there were several cables to neutral shores, but Dewey found no diffi-

The rapidly advancing development of the Far East demands the speedy completion of the world's electrical girdle. England's road to China across her vast North American

culty in severing the Manila cable. If Great Britain should become involved in a European war and all her several lines to India be cut, is it supposable that island specks in the Pacific could be defended against marauding cable cutters? In time of war a national cable becomes at once, in its whole length, so much more frontier exceedingly vulnerable and impossible to defend against the most insignificant enemy.

The real prize in sight for a Trans-Pacific cable is not the transmission of war despatches, but the Asiatic business which shall be briefly considered in comparison to European trade, in its actual volume and in its prospective growth.

The foreign trade of the United States with Europe, facilitated by thirteen cables and several more building, is about $1,200,000,000 annually. The total foreign commerce of Asia amounts to $2,000,000,000 and it is helped by three cables from Bombay via Aden, one Persian Gulf line via Asia Minor, and one Russian overland route.

The north-eastern Asiatic trade amounts to $656,000,000, of which the United States in 1897 had secured $112,000,000, or about one-sixth. This business, with the densest population in the world back of it, is as naturally tributary to the United States and Canada as the trade of the Hawaiian Islands is tributary to San Francisco, which has secured 99.79 per cent. of the exports from, and 76.27 per cent. of the imports into, the islands. The possession of the Philippines by the United States, the development of Japan, the awakening or partition of China, the completion of the Siberian Railroad (which will be finished in two years), will enlarge the trade of Asia to a volume commensurate with population and North America should secure most of it. Mr. Herbert H. D. Peirce, first secretary of the United States embassy to Russia calls this latter country, as opened by the new railroad, an immense field far beyond anything realized by Americans for the introduction of machinery and for an unlimited market of manufactured goods. Mr. John Barrett, formerly United States Minister to Siam, who has made a special study of Asiatic trade gives the single island of Java, which is but little larger than the state of New York, an annual foreign trade of $250,000,000; yet Java has only half the extent of fertile areas credited to the Philippines. He gives to Hong Kong in 1897 a total also of $250,000,000,

colonies, and America's route to her new Pacific possessions, must be paralleled by a Trans-Pacific cable. But it must be a practicable, commercially valuable line—not a national fetich. Mr. Emerson is finishing a thorough study of the entire question, in which he has had invaluable aid and exceptional facilities afforded by officials and by the great telegraph companies. His conclusions, imparted in this paper, are of particular interest and importance at this juncture to the English speaking world on both sides of the Atlantic. THE EDITORS.

and to Singapore $180,000,000, and for the Asiatic coast from Singapore to Vladivostok the mighty sum of one billion dollars and yet, he adds, the foreign trade of this wonderful Pacific Asiatic coast line is only in the earliest stages of its development.

Elsewhere, urging the laying of a Pacific cable, he says that the tremendous monopoly of the present telegraphic connection between the far east and America is a great handicap to the development of trade with the United States, and that he has frequently heard merchants of all nations in Asiatic ports say that the cost, time, and difficulties of cable connection with the United States works against the extension of American commerce.

With cable connection, Mr. Barrett estimates the probable increase of Philippine trade alone in the next fifteen years at 300 per cent. It is therefore within reason to estimate the growth of all the Asiatic trade at 50 per cent. in the next ten years, and if the proportion obtained by North America becomes 25 per cent. of the whole, there would be an increase in American business to $600,000,000. This is a prize in the telegraph field that is worth securing by being first in the field, obtaining as many privileges and connections as possible, and reaping for years all the benefits of non-competitive business.

An unbiased review of the different proposed telegraph routes from North America to Asia excludes consideration of private promoting and constructive interests. A cable might be laid on a line that is commercially impossible, a fact which would not necessarily deter those who expect to furnish the material for, or to profit by the laying of, the line from advocating it, especially if governments can be induced to grant subsidies which would more than meet the whole interest charge and cost of maintenance.

Deep-sea and long cable laying are not untried experiments; the deepest cable laid is the short stretch from Haiti to the Windward Islands, in three thousand fathoms, and the longest cable is the French line from Brest to Cape Cod, 3,110 sea miles, which includes the usual allowance of 10 per cent. for slack. A short deep cable is not a serious problem, nor is a long cable in medium depths; but the combination of extreme length and depth adds very much to the hazard and difficulty of any cable undertaking.

Unless a heavy copper core is used, long cables are so slow as to be almost valueless commercially; but a heavy copper core means heavy insulation and heavy sheathing, resulting in a costly cable, difficult to lay in deep water and troublesome to repair. The core of the long French cable is made up of thirteen copper wires of different

gauges, weighing 660 lbs. per mile; it is insulated with 396 lbs. of gutta percha per mile. The total weight is 10,000 tons. The standard core for submarine cables under 1,000 miles in length is 107 lbs. of copper per mile.

The difference in cost between long cables in deep seas far away, and short cables in shallow seas near manufacturing centers, is shown by the comparison of the contract price for the Denmark-Iceland cable, and the estimates of the British Commission for the proposed British-Pacific cable. The distance from Denmark to Iceland, with a landing on Scotland, is 900 miles and the route lies through shallow northern oceans. The contract price is 450,000 Kroners,* $134 or £27, 10s. per mile. The Althing of Iceland contributes 150,000 Kroners and the Great Northern Telegraph Company, of Copenhagen, the balance of 350,000 Kroners. The estimate for the Vancouver-New Zealand cable—a distance of 7,986 n. miles with one long stretch of 3,561 miles—is £2,000,000, equalling £250 or $1,220 per mile. In the one case a mere filament of copper and insulation is used, which is cheaply laid by a small steamer; in the other case, the minimum proposed by Lord Kelvin is 552 lbs. of copper and 368 lbs. of gutta percha per mile. It is not a small item of expense to fit up a cable steamer that can carry 10,000 tons of cable and the necessary coal for a 3,500 mile trip. The annual maintenance cost of this long cable, exclusive of operating expense, is put at $350,000 annually. Owing to its one long stretch of 3,561 miles, this cable costs per mile nearly ten times as much as the 900 mile Icelandic cable in two stretches. These are extreme examples, one, the cheapest long cable in the world; the other, the most expensive.

Several projects subserving private rather than public interests have been promulgated on both sides of the Atlantic, and specious arguments have been advanced in favor of exclusive national lines. The arguments, however weak, are offered in the hope of creating an uncritical enthusiasm on the wave of which some government can be induced to vote financial support.

The ideal Trans-Pacific route is the one promising:

1. To secure the largest amount of present business.
2. To develop the largest amount of new business.
3. To cost the least money to lay.
4. To be laid and maintained most easily and cheaply.
5. To be operated most rapidly and with least interruption.
6. To be politically most valuable.

* The Kroner is equal to 26.8 cents, or about 13 1-2d.

A legitimate cable enterprise across the Pacific is not one depending on government subsidies as the only protection against bankruptcy, but one in which commercial and government business will pay both maintenance and interest.

Four Pacific routes have been proposed, and the arguments in favor of each will now be considered by these tests—commercial, financial, physical, electrical, and political—and thus an unbiased conclusion be reached as to which is preferable. Of the four proposed routes one is British (running, not across the Pacific, but north and south through it), one American, and two are international.

Owing to its length, cost, and difficulty, the British cable from Vancouver, B. C., to New Zealand easily ranks first as an ambitious project. Its length is 7,986 nautical miles. The American route, which is proposed from San Francisco to the Philippine Islands, via Hawaii, is 6,640 miles. The shortest of all the routes is the international route of 3,687 n. miles via the Pacific coast of North America to connection with Asiatic lines, and the fourth route is an international overland route via the Yukon River and by short cables to Asia, a revival of the old Western Union overland route to Siberia.

THE BRITISH CABLE.

Vancouver to Fanning Island.....	3,561	Nautical Miles.
Fanning Island to Fiji.....	2,093	"
Fiji to Norfolk Island.....	961	"
Norfolk Island to New Zealand.....	537	"
	7,152	"
Branch from Norfolk Island to Queensland	834	"
Total	7,986	Nautical Miles.

A fact not brought to the attention of the commission is that the long stretch can be shortened a few miles by laying from the north end rather than from the south end of Vancouver Island.

In considering the probable volume of paying business for any cable, the way stations, terminals, and the world beyond the terminals must all be taken into account. In this British cable the way stations are insignificant. Fanning Island, inhabited by a dozen persons, is a small coral reef in the Pacific Ocean, about 1,000 miles south from Honolulu. The Fiji Islands and Norfolk Island are not important,

the former having a population of 110,000. The terminals—British Columbia and New Zealand, both magnificent colonies—are very similar. Both lie in the temperate zone, are mountainous, sea-girt, sparsely and recently settled; the chief products of both are wheat, lumber, fish, and minerals, and, owing to this similarity, no very great interchange of products either exists or is from the nature of the case to be expected.

The great volume of business must come from the commercial world beyond the terminals—North America and Europe on the one side, the whole of Australasia, India, southern and eastern Asia, on the other; but it is at least questionable whether much of this world business would be diverted to this circuitous route. Competing lines via southern Europe are much shorter from London to India and Japan, shorter even from London to New Zealand, and these lines not only have their business well established, but will lower their tariffs to retain it. It is also to be apprehended that the construction of a direct line between North America and northern Asia will take the larger part of all commercial business; for who would cable from Vancouver to Japan or China, via New Zealand, if he could reach these points in one-third the distance and time?

The All-British cable certainly does not follow established trade routes, and this objection was made to it by Mr. Lucas before the British commission. It is not a route that can secure the greatest amount of paying business. This is not, however, the only nor the most serious objection. The first stretch of 3,561 miles, from Vancouver to Fanning Island is 450 miles longer than any cable yet laid, and this extreme length makes this line very costly to build. The difficulties of laying the cable will be greater than hitherto experienced, because it is longer and heavier and because the sea is deeper, even to 3,000 fathoms for hundreds of miles at a stretch, with possible holes of greater depth. A known hole of 5,515 fathoms (not on the route) was brought to the attention of the British commission, as a warning of a contingency to be met almost anywhere in the south Pacific.

It is on account of this depth and length that the cost of maintenance is put at £70,000 per annum and of operation at £22,000 per annum. A business of 750,000 words per annum at 75c. or 3s. a word (three times the Atlantic rate) is estimated in order to earn gross £178,000, and even this sum is less than 4½ per cent. net on the first cost.

Wires of 650 lbs. of copper per mile, or 96 lbs. more than proposed for a distance of 3,561 n. m., have a maximum theoretical speed

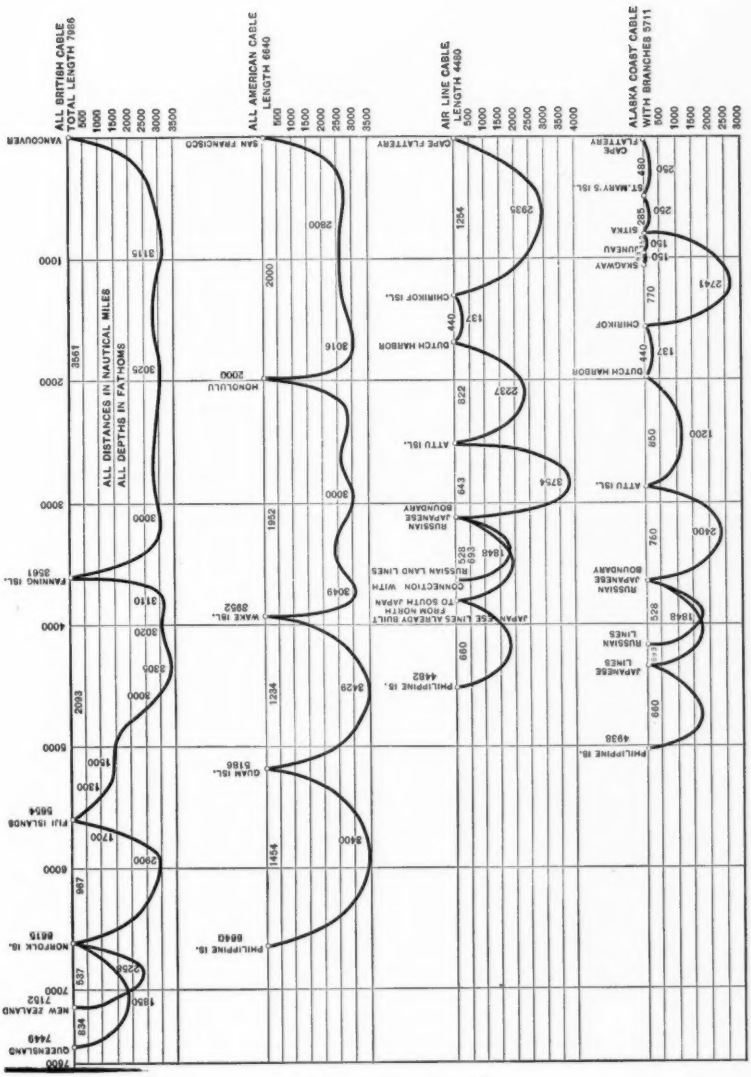


DIAGRAM SHOWING COMPARATIVE LENGTHS, DEPTHS, AND SPANS OF PROPOSED PACIFIC CABLES.

of sixty to ninety words a minute, and the various experts reduce this to practical speed of paying business of from four to forty words per minute. This wide variation in estimate emphasizes the uncertainty of this experiment. This long north-and-south cable would, however, be free from the magnetic disturbances that are liable to cause trouble on northern land or sea lines.

So unpromising is this cable from a commercial point of view that it is advocated solely on sentimental grounds. It is called the "All-British" cable because it touches only British possessions. Its promoters deplore that Bird Island, 150 miles west, northwest of Kauai, and only 2,600 miles from Vancouver, is not a British possession. That it is not is because the vessel despatched to annex it as an unclaimed island arrived too late, the Hawaiian flag having been raised the preceeding day. Now, notwithstanding an offer, a landing on Hawaii is distinctly rejected, because, in spite of the additional business from Hawaii, a station on foreign soil would at once deprive this cable project of the only argument with which it can be defended, namely that it is All-British.

Because it can never be made to pay commercially, the mother-land and all the colonies which this line touches are asked to contribute the capital required to build it, and its promoters refuse to consider an annual subsidy of £20,000 a sufficient guarantee to induce private capital to subscribe to the undertaking.

THE AMERICAN CABLE VIA HAWAII.

This route, as originally proposed, ran from San Francisco to Hawaii and thence to Japan, a rational and sensible route, yet a thousand nautical miles longer than from San Francisco to Yokohama, via the northern route. Recently, owing to the expansion fervor, its American advocates have copied in a weak and diluted way the British arguments and now suggest an "All-American" cable to the Philippines.

The stations are:

San Francisco to Hawaii.....	2,000	Nautical Miles.
Hawaii to Wake Island.....	1,952	"
Wake Island to Guam.....	1,234	"
Guam to Philippines.....	1,454	"
Total	6,640	Nautical Miles.

It has been openly charged that any cable reaching Hawaii will stop there, and the selection of Wake Island as the next landing place

gives weight to this charge. Wake Island is a very small uninhabited coral reef thus described by Chas. Wilkes, U. S. N., who visited it in 1841. "Wake Island is a low coral one of triangular form, eight feet above surface. There is no fresh water on the island and neither pandanus nor cocoanut trees. The rise and fall of the tide was three feet. From appearances the island must be at times submerged or the sea makes a complete break over it; the appearance of the coral blocks and of all the vegetation leads to the conclusion, showing also that the violent winds or rush of the water when the island is covered are from the westward." *

Wilkes' survey of this island was corrected in 1898, with the remark that the island is from five to fifteen feet above high tide with rise of tide about six feet. The last reports on the island are dated January 17, 1899, on which date observations were made by the U. S. S. Bennington, with the following remarks: "No anchorage. Entrance to lagoon closed. Island is in some places twenty feet above water. Nothing was seen to indicate that the sea breaks over it." In view of the fact that the barometric wave is eight feet, that the tidal wave following earthquakes is often forty feet, that storm waves in those vast reaches of the Pacific may be very high—it seems impossible that this island should not be frequently submerged, and while it has been suggested that a high tower could be built in which to land the cable and in which the cable operator might find refuge, the same authority also insisted that a ship should visit the island every few months and replace the employees, who by that time would probably be insane and playing havoc with the messages.

If the uninhabitable Wake Island is discarded as a cable landing, the stretch between Hawaii and Guam becomes 3,186 miles, and this is only slightly less objectionable in expense, difficulty, and uncertainty than the Vancouver-Fanning stretch of the All-British cable. Four surveys have been made from California to Hawaii. The depth found on all of these is from 2,500 fathoms up to 31,000 fathoms. Two surveys have been made west of Hawaii, and on one the depth reaches 3,287, and on the other 3,409 fathoms. A few miles southwest of Guam, the sounding is 4,475 fathoms, and, while this hole can be avoided, depths of 3,400 fathoms between Guam and the Philippines must be reckoned with.

It is highly desirable for the United States to have more direct cable connections with the Philippines than 14,000 miles, via Europe,

* United States Exploring Expedition. V. 5, pp. 267-268, Charles Wilkes, U. S. N., 1845, 5 vols.

and it is also highly desirable to connect Hawaii with the United States by cable; but this latter project should be considered on its own merits and, even if a heavy cable were now in operation to Hawaii, it would still not be a way station on a direct Asiatic line. All the Hawaiian business can be safely handled over a thin, and therefore cheap, cable. The Hawaiian Islands have a total population of 109,000, nearly all Asiatic coolies. The business is principally with San Francisco and in the hands of a very few firms, mostly American. No cable can greatly increase American trade with the islands.

This cable via Hawaii, not even the shortest route to the Philippines, owing to the length of its links, the enormous sea depths, the ocean wastes, is scarcely less to be condemned than the All-British cable. It can never be built without a subsidy that must amount to a guarantee of a substantial rate of interest on its entire cost, because the volume of commercial business over it will always be small. Its cost is estimated by Z. S. Spalding, president of the Pacific Cable Company, of New Jersey, at $10,000,000, and the cost of a cable to Japan, via Hawaii, is estimated by Jas. A. Scrymser, president of the Pacific Cable Company, of New York, at $7,000,000 or $1,034 per mile.

It is not generally known that the nearest point in the United States to the Philippines is Cape Flattery, the northwest corner of the State of Washington, from which point the distance by air line or great circle, all the way to the Philippines, is 5,400 miles—700 miles less than from California, via Hawaii.

All the Atlantic cables follow great circles as closely as conditions will permit, but the two new Atlantic cables will diverge from this short course and be laid far to the south via the Azores, because there is no other way in which the long single stretch from Ireland to Newfoundland can be broken into two shorter links, and, notwithstanding the increased cost and greater aggregate length, there will be gain in speed and economy.

The western cable builder is more fortunate than his Atlantic forerunner, because in the Pacific the short great-circle route is also the route of shortest links. It does not run through the wastes of the Pacific, but follows closely the British and United States north Pacific coast, which is so rapidly growing in importance, runs through Dutch Harbor in Alaska, touches Attu, the last of the Aleutian Islands and until recently the most westward possession of the United States, crosses in short links to the Russian-Japanese boundary, with one branch to connect with the existing Siberian net-work of land lines,

and the other branch to run down through Japan (Yokohama being on the air line), and onwards to the Philippines, looping, on its way from Attu to Manila, the whole of the rich Asiatic coast to North America.

THE GREAT CIRCLE CABLE.

Cape Flattery to Chirikof Island....	1,254	Nautical Miles.
Chirikof Island to Attu, via Dutch Harbor	1,262	"
Attu to Russian-Japanese boundary..	643	"
Boundary to connection with Siberian land wires.....	528	"
Minimum of mileage to connect with all Asia.....	3,687	"
Cable from boundary to Japanese land lines.....	693	"
Cable from Japanese lines to Philippines	600	"
Total	5,040	Nautical Miles.

This system gives two wholly independent lines from Russian-Japanese boundary to the Philippines—one line via Vladivostok, Pekin and Hong Kong, and the other via the Japanese lines. To interrupt Asiatic communication, the United States would have to be at war with both Russia and Japan, or with Great Britain and Japan. In the former case, communication is still open as at present via Europe, and in the latter case danger on both Atlantic and Pacific coasts would be so great as to make communication with the Philippines a secondary matter.

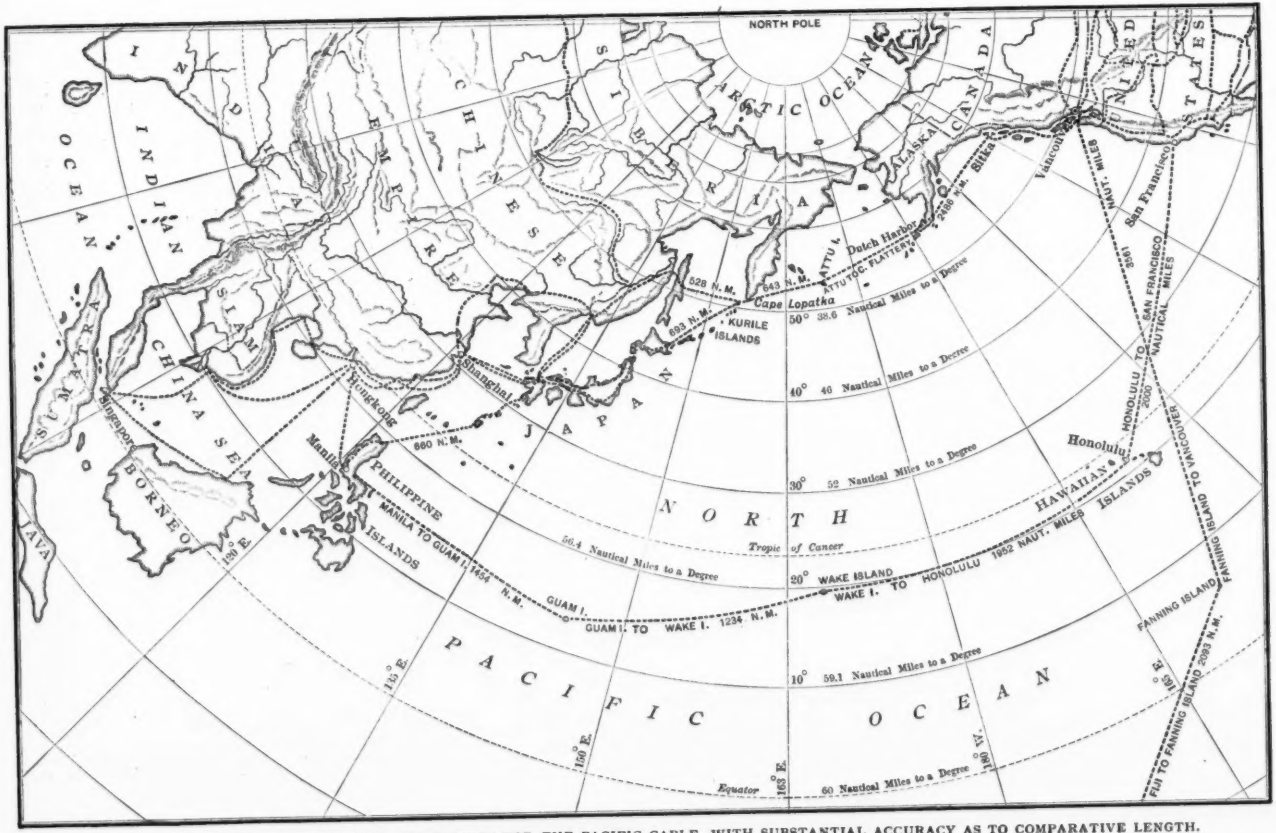
Stretches of over 1,200 miles are given in the table, but the longest necessary link is 528 miles. Everywhere else this cable lies so close to land as to permit intermediate stations, whenever desirable. This makes it possible to use the Morse instrument, thus adding very greatly to the speed of transmission. It would be no serious matter to add a few miles to the length of these short shore lines and to run via Mary's Island, Sitka, and Cook's Inlet, with a branch to Juneau and Skagway, thus bringing the whole Alaskan coast into cable communication with the United States. This is a necessity which sooner or later must be met, and only those who have been in Alaska know the millions of dollars and the hundreds of lives such a line would have saved, had it been in operation during the last two years.

In the joy over the new island possessions with their Asiatic inhabitants, the United States should not forget that all the Philippines are only one-fifth the size of the enormous Alaska, to which there has been a rush of 30,000 of their citizens in the last two years.

Not the least important service of a cable, via Alaska, would be daily meteorological reports to the weather bureau from Dutch Harbor, Attu, Bering Island and Choumchoum Island—reports of incalculable value in all weather predictions for the whole United States; if this route had no way stations and led nowhere, its meteorological importance alone would justify a heavy expenditure of money. It will, however, be subjected to the same tests applied to the other proposed routes.

The way stations of importance are Juneau, Skagway, and Dutch Harbor. All the Alaska and Yukon business to the gold regions goes either by way of Juneau and Skagway, or by way of Dutch Harbor, and this business in and out amounts to $40,000,000 annually and is steadily increasing. It is in the hands of at least ten thousand active men, and, owing to the impossibility of mail transmission during many months in the year, there must be much cable business. The shipping and passenger interests are very great and steamers arrive at Skagway from the south almost daily, carrying each month nearly as many American citizens and British subjects as all the coolies carried in a year from Asia to Hawaii. In local business, therefore, this cable will be much better patronized than either of the other cables.

The North American terminals are two of the most rapidly advancing regions in the United States and Canada, namely, the State of Washington, which in the last census showed a greater percentage of increase than any other State, and British Columbia, the most energetic of all Dominion provinces; for, while other parts of Canada cannot prevent their inhabitants from emigrating to the United States, British Columbia has to pass laws to keep out Americans, for fear they will overrun it. The Asiatic terminals are the already built Russian and Japanese lines, and this cable thus unites four of the leading and most progressive nations of the world. If the Philippines be considered the objective point, Asiatic Russia, Japan, Corea, and China are way stations on the route. Alaska (including British Yukon) has a total trade of $40,000,000; Japan's foreign trade has grown from $59,000,000 in 1893 to $221,600,000, and in the same time her imports from the United States have grown from $3,000,000 to $20,000,000; Corea has a foreign trade of $10,000,000, Asiatic Russia of $51,000,000, China of $277,000,000—a total of $599,000,000, ex-



POLAR MAP SHOWING VARIOUS PROPOSED ROUTES FOR THE PACIFIC CABLE, WITH SUBSTANTIAL ACCURACY AS TO COMPARATIVE LENGTH.

clusive of the Philippines. With the exception of the Russian business, all of this will find this cable the most direct and cheapest route, not only to the United States and Canada, but to Great Britain, Germany, and France. The business, great as it is now, has but begun. Before the cable can be laid the Siberian Railroad will be completed to the Pacific. Already four Trans-Pacific lines of steamers run past Cape Flattery to Japan, a dozen different lines run up the Alaskan coast, there is a monthly service to Dutch Harbor. This activity sufficiently indicates that this cable is on the "track of trade."

The estimates for the southern cables were $7,500,000 and $10,000,000 respectively. For the short northern cable, to connection with both Russian and Japanese lines, the estimate is $2,400,000, or $500 a mile, which is $20 a mile more than the estimate of the British Commission (£53,000 for the 573 miles of British cable from Norfolk Island to New Zealand). Three million dollars will build the whole lines, including branches to Skagway, to Russia, and the 660-miles length from Japan to the Philippines.

The commercial rates now in force from London to Vancouver and Seattle are less than 35 cents per word, but the rate from London to Japan is $1.50, via Siberia, and $1.90, via Suez, and to Hong Kong, $1.40. (From New York it is 25 cents per word higher.) A dollar-per-word rate from London to Japan, 75 cents from New York, 65 cents from the Pacific Coast (this latter being one-third the present rate), ought to secure a large share of the business, and, instead of asking Japan for $200,000 per annum and the United States for $175,000, which is a guarantee of 5 per cent. on the alleged necessity of spending $7,500,000, the Alaskan coast cable could well ask Japan, Russia, the United States and Canada between them to guarantee $150,000, unless otherwise earned. With such a guarantee, and with its paying local business, this cable could dictate terms to the European-Asiatic lines and obtain a renunerative share of the business.

Not only is this cable in short lengths, cheap to lay and easy to repair, but the sea depths are not excessive. The deepest sounding between Sitka and Attu is 2,741 fathoms, the deepest between Attu and the Russian-Japanese boundary—(Choumchoum Island and Cape Lopatka) via Bering Island is 2,400, and the deepest in the Sea of Okhotsk is 1,848 fathoms. From its American-Canadian terminal to Sitka, a distance of 765 miles, the cable lies in shallow, smooth water, and breaks could be quickly repaired by a small tug boat. From Sitka to Chirikof Island it would

add but a few miles to the distance to lay the cable within the thousand-fathom line. From Chirikof to Dutch Harbor, 440 miles, the depth is but 137 fathoms. The cable should be laid through Onimak Pass from the south to the north of the Aleutian Islands, because the north side has better harbors, is freer from fogs and storm, has shallower and more even bottom, and is also in a more direct line. The pass is nine to ten miles wide in its narrowest part, is clear of hidden dangers, free from dangerous tide rips, and with less tidal current than any other pass. The cable should land in Unalaska Bay, which lies between Cape Kalekhta and Cape Cheerful, and is commercially the most important bay in western Alaska. On the east side of the bay are the important anchorages of Iliuliuk Bay, Dutch Harbor and Iliuliuk Harbor. Cape Cheerful, the western entrance to Unalaska Bay, is made of bold, very high headlands, intersected by deep grassy valleys. The shore is free from dangers and has deep water close to. In Dutch Harbor a wharf 200 feet long extends to deep water, and at the outer end large ships can lie.

Three objections have been made to the northern route. They are that it lies in perennial fog banks, that it crosses the track of severe storms, that owing to its northern path it is subject to magnetic interference. The truth is that the region is not more stormy or foggy than the north Atlantic, through which the thirteen European-American cables are laid. Nor is the ocean further south a region of perennial calm. In the spring of 1898 one of the large Nipon Yusen Kaisha steamers, on her way from Hawaii to Seattle, rolled almost continuously 45 degrees by pendulum measurement, and in September of the same year another steamer of 2,000 tons, which had safely in winter time made the trip from New York to Seattle around South America, was shaken to pieces 400 miles northeast of Hawaii. On neither occasion would it have been an easy task for any steamer, however large, to grapple for a broken cable in 3,000 fathoms.

Alaska generally seems subarctic, and the erroneous impression is conveyed that a cable via Alaska must lie very far north. In reality, all of it lies south of the latitude of Aberdeen, Scotland. It runs northward to Sitka (57° north latitude), thence southwestward in an air line to the north islands of Japan. At Sitka it is but 300 miles north of the Atlantic cables landing on Ireland. Magnetic disturbance can be but inappreciably greater than in the Atlantic cables, and apprehension on this score may be safely dismissed.

There are no data by which accurately to estimate the probable amount of paying business on any cable line, but an estimate can be

made of the fixed charges and from these the volume of business at a given tariff be stated, necessary to make the enterprise a paying one. The British commission has made such estimates for the All-British cable, and these give a basis for equally valuable guesses for the Alaskan Coast cable. For convenience of comparison these estimates are tabulated together.

	First cost.	Int. 5% Sinking fund 3%	Maintenance.	Operation.	Total.	No. of words to earn this at 75c. a word.
British Cable.	$10,000,000	$800,000	$350,000	$110,000	$1,260 000	1,680,000
Alaskan Coast Cable.....	$3.000,000	$240,000	$114,000	$70,000	$424,000	565,300

There remains one more route to consider, namely:

THE OVERLAND ROUTE, VIA THE YUKON RIVER.

As is well known: the Western Union Telegraph Company attempted to explore an overland route to Asia and thence on to Europe (before the Atlantic cables were a success, and when it was still feared that so long a cable could not be successfully operated). It is said that several million dollars were spent in this attempt. Telegraph Creek, on the Stikeen River, in British Columbia, a place that acquired some prominence last year as a possible starting point for an all Canadian overland route to the Klondike, is in its name a reminiscence. At that time San Francisco was the nearest telegraph point on the Pacific coast, and nearly all the way to Bering Straits, a distance of 4,000 miles, was an unexplored wilderness. All this has been changed. The Yukon valley is now well known and travelled summer and winter from Bering Sea to Skagway. Over the worst part of it all, the divide between the Pacific and the headwaters of the Yukon, a telegraph line has been built, and was in operation last winter. A railroad runs over this pass, and the telegraph line has been continued well down towards Dawson. The Canadian Government has undertaken to put in the line between British Columbia and the Yukon valley, and thus Dawson will soon be connected by wire with the civilized world. A line of less than a thousand miles, and through a country less severe in climate and in snow fall than the upper Yukon, would connect Dawson with St. Michaels, the port at the mouth of the Yukon. Thence by a series of short cables, either via the American islands, St. Lawrence, St. Mathew and Attu, or from headland to headland on the Asiatic coast, the Russian-Japanese boundary could be reached.

One thousand miles of land line and two thousand miles of short

cables would connect Dawson with the Russian or Japanese lines, but the objections to this project are many. Owing to the high latitude a long land line is very liable to magnetic disturbance, especially in winter; it is also liable to break-downs from storm and snow, which might interrupt communication for several days at a time. I have seen hoar-frost form a rope six and eight inches in diameter on the line north of Skagway, and break it down repeatedly. There might be even more trouble with the cables. Bering Sea is very shallow, its shores are ploughed by fields of floating ice, which might rake up the shore ends of the cables, and repairs, in case of break, would be impossible, except in summer time.

Which of these four routes shall be selected—or, unfortunately, shall two or more lines be attempted at once?

A great commercial enterprise is incompatible with a narrow nationalism. If the western coast of North America is to reap the Asiatic harvest, ready for the gathering, a direct Pacific cable must be laid to Asia, as business cannot successfully be transacted either via London or via Australia. If the United States and Canada are conscious of their imperial position between the two great oceans of the world, between the great marts eastward and westward, they will not long permit this last ocean to remain unspanned. Here is a great world market at their western door, opening a hungry mouth for food and clamoring for manufactures, both of which North America so abundantly and splendidly produces. In spite of their misunderstanding over the Alaskan frontier, Canada and the United States should join hands in laying the shortest and best cable to the oriental world, forcing European messages and European trade to come their way through the San Juan de Fuca Straits, with its cluster of American-British cities, through the great Columbia River to Portland, through the Golden Gate to San Francisco.

It is not an impracticable and ruinous national cable, whether British or American, that is needed, but a cable that will bind closer in friendship and in swelling trade relations the United States, Canada and Great Britain of the west—Russia, Japan, China and tropical Asia in the east.

ELECTRIC POWER DISTRIBUTION AND THE SMALL CONSUMER.

By Louis Bell.

ONE of the toughest problems that faces the political economist is the preservation and regeneration of small industries. The present tendency is toward the aggregation of both population and industry into a few well-defined centres. It is idle to say that this is the natural course of progress, proceeding from well-defined economic laws, useless and needless to combat. On the contrary, while man is naturally a very gregarious animal, and certain localities are unquestionally more advantageous than others, the major part of the centralization of industry, in its most modern phases, arises from the effort to control and inhibit the operation of economic laws. For example, the arbitrary limitation of production, the temporary sale of products below cost to suppress competition, the whole complicated system of equalization of freight rates—all these are purely artificial methods of forcing industry out of its natural channels, which themselves, like river beds, shift from time to time. To such processes, generally contravening the public good and often the laws of man and God as well, is due no inconsiderable part of those industrial changes which are affecting so disastrously the distribution of wealth and prosperity. But one must face the problem as it is. The existing condition is that the distributed industries of the country are steadily passing away, towns once prosperous are declining, thriving villages are being succeeded by tumble-down hamlets and well tilled farms by weed-grown pastures. This is no fanciful picture; it reproduces, with uncompromising fidelity, what all may see who overlook such parts of the United States as are not purely agricultural in their interests. Meanwhile the larger cities are growing with mushroom-like rapidity, and the whole trend of events is toward economic development of a terribly unstable character, likely to alternate between feverish prosperity and complete prostration.

The subject is one of gigantic proportions and ominous of disaster, too vast and complex for treatment by any single hand or along any single line. It is the purpose of the present paper merely to point

Dr. Bell's paper fulfils the promise with which his article in the preceding issue of THE ENGINEERING MAGAZINE concluded. He shows how the centralisation of power ministers to the distribution of industry. It is one of those beneficent paradoxes o

out how some of the forces that make for progress, and with progress bring some evil concomitants, may be turned to remedy the evil.

In theory, production on a large scale, other things being equal, must inevitably prevail. But, in the first place, the curve which expresses the relation between cost and output in many cases rapidly becomes asymptotic, and, in the next place, the other things seldom are equal, and may be made to favor the small as against the large producer. In a previous paper I have explained how modern methods of work-shop development, when carried beyond a certain point, may tend to defeat their own ends. The same tendencies operate in a more general way to produce the same results in almost all industries, the more powerfully in those branches of manufacture which call for high individual skill on the part of the workman.

The three prominent essentials of cheap manufacture are cheap labor, cheap power, and cheap raw material; with these we must also consider cheap distribution of the finished product. In the earlier stages of industrial growth, while production was still distributed, manufactures gathered around the sources of material, near water powers, or at the seaboard, according to the relative importance of these various factors of cost—labor being, for the time, fairly uniform. With the coming of the railroads, the transport of material and product became relatively cheap, and railroad centres became, if power was available, economical points of manufacture. The stress thus put upon other districts forced labor to follow on to the cities, which, with the introduction of machinery, steadily cut down the labor cost, while low railroad rates on through traffic have steadily increased the advantage of the large centres of population. One might naturally suppose that the higher cost of living in cities might increase the cost of the labor item, but the sharper struggle for existence has more than offset this difference. The upshot of the matter has been that the distributed industries have been, as a rule, slowly starved out of existence until, one after another perishing, the whole industrial situation has changed. In a few instances, brickmaking for instance, widely scattered raw material, with product costly to transport, has prevented the concentration of manufacture; but these are exceptions.

If the present condition—disastrous in its effects on the earning

industrial evolution which are so generally unforseen or misunderstood by superficial students and thinkers. As labour-saving machinery has largely emancipated the workman from drudgery, while immeasurably increasing the field for his employment—as specialisation, according to Sir Benjamin Browne, elsewhere in this number, is destined to individualise, and not formalise, his effort—so, Dr. Bell maintains, centralisation of power may afford, in the end, the solution for over-concentration of the labouring population. THE EDITORS.

power of the people at large—is to be changed, it must be through changing the factors upon which cheap manufacture depends. Bringing a cheap product to the consumer is undeniably a good thing; but if this end can be reached without a centralization that materially lessens the consumer's relative earning power—so much the better.

The factors of cost most susceptible to attack are the cost of power and the cost of local transportation, both of material and product. The first mentioned is usually rather high in the larger cities, but higher still away from them owing to the heavy transportation charges on fuel. Save in the case of some of the older cities, built up around water powers, these are more available in country districts; but, again, the transportation facilities are generally bad, since the immediate vicinity of good waterfalls is apt to be a difficult country for the construction of a network of railroads.

The electrical developments of the last decade have, however, cleared the way for at least a partial solution of this difficult problem of saving and restoring distributed industries. The most sanguine engineer would hardly put forward his art as a panacea for these economic ills—other and more drastic remedies must come at the hands of the long-suffering people if they would save themselves from industrial serfdom; but, nevertheless, electric power is no insignificant factor in the situation. At the present time we must look upon water powers not merely as local privileges, but as available anywhere within a radius of, say, twenty-five miles in almost every instance, or at several times that distance in regions where fuel is dear.

A twenty-five mile transmission is to-day a mere commonplace of engineering, a little longer than is usually necessary, but in other respects quite in accordance with every-day practice. And this means that if, within such distance of a water power, there are locations otherwise desirable for manufacturing purposes, the power user there will be in a better situation economically, so far as cost of power is concerned, than his large competitors who have to depend upon steam. And all along the line of such a transmission this industrial advantage exists. It is only very recently, however, that the full significance of the situation has become manifest in its application to scattered manufactures. We have been wont to look on a power transmission as something like a trunk line between well-defined termini, but now we should do well to apply to it something of the theory of railroad location and note, not alone the ends of the line, but what points between may be profitably served. Frequently, indeed, these opportunities are not overlooked; but the first important transmission de-

liberately intended for serving a distributed industry we must place to the credit of our Gallic friends, to whom, moreover, we owe the very beginnings of electrical power transmission.

This notable enterprise, which marks, perhaps, the beginning of a path that leads to far wider fields, was inaugurated to save the ribbon-weaving industry in that part of the Loire valley that lies near St. Etienne. Ribbon weaving is there the most important local employment, and until a few years since it had been for several generations carried on entirely upon hand looms, excellent for the purpose, but obviously unable to compete with large factories equipped with power looms. It formed the chief support of more than a score of towns and villages, for the looms were rarely gathered in factories, but scattered from house to house in small work-shops containing seldom more than two or three looms. It was practically work done in the homes of the weavers, and the trade was passed down from father to son. Under the competition of improved machinery in city factories, the industry around St. Etienne languished, and villages and work-shops seemed doomed to extinction. The crisis had become serious when the Compagnie Electrique de la Loire undertook to avert the catastrophe.

The resulting system is shown upon the map (p. 245). The first step was the installation of the water-power station at St. Victor-sur-Loire, having 900 h.p. in turbines and a steam reserve of 600 h.p. The three-phase system was adopted, the voltage of transmission being 5,200. This initial station was 15 kilomètres from St. Etienne, and it was soon followed by a 400-h.p. hydraulic station at Pont-de-Lignon, about 40 kilomètres from St. Etienne. In the latter town, three steam-driven stations were installed, aggregating 900 h.p. more. The distribution, in every case, is at 190 volts for motors and 110 volts for lighting. The system has been steadily extended from town to town, until at present the total length of the transmission lines aggregates 110 kilomètres (nearly 69 miles) with thirty-six transformer stations from which power and lights are distributed. From these are operated two thousand five hundred ribbon looms, 100 h.p. in miscellaneous motors and eight thousand incandescent lamps. A ¼-h.p. motor serves for each loom, so that the total load connected amounts to about 1,400 h.p. All the lighting is outside of St. Etienne, since the local gas company holds exclusive rights there. The charge for power to the weavers is 10 francs per month for each ¼-h.p. motor. As far as can be learned, the system has been an all-around success, and the substitution of power for hand labor has greatly im-

proved the industrial conditions, in spite of the fact that, through the slow conservatism of the small weavers, many hand looms are still in use. To encourage further use of motors, arrangements are made for the supply of the motors at a nominal rental, or the user is at liberty to furnish his own motor, if of a kind suitable for installation upon the circuits.

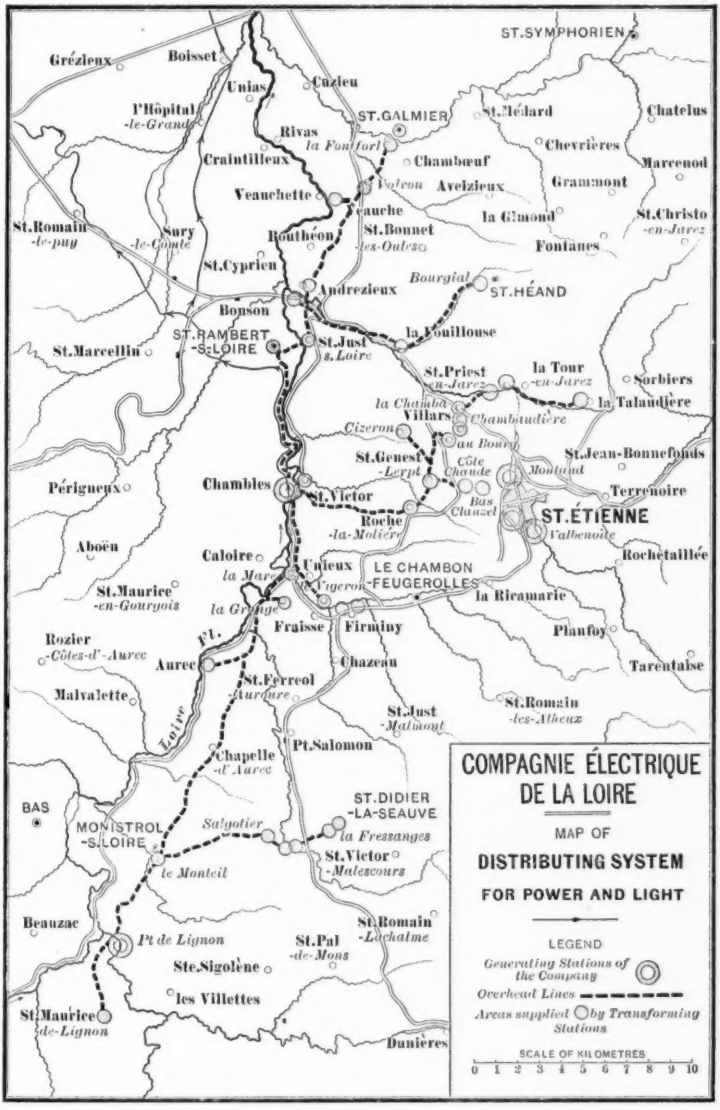
This St. Etienne transmission is at present absolutely unique in the great area supplied and in the almost complete absence of large customers.

Of course, the fundamental question about so scattered electrical distribution is the financial one:—Will it pay? At the St. Etienne rates there can be no doubt of an affirmative answer. Competition there is between hand labor and motors, and the latter obviously have the advantage. A more searching inquiry would be as to whether a similarly extensive distribution from water power could profitably furnish power to small consumers at rates comparable with the ordinary cost of power to larger users in cities. The best answer is the solution of a hypothetical case involving the above conditions.

For simplicity, we will assume a plant of about 1,000 kilowatts normal capacity, distributing power 25 miles in two directions, thus being located nearly midway of a 50-mile line, and delivering power and lights from, say, twenty points. This is somewhat less elaborate than the St. Etienne distribution, but the latter has the advantage of a shorter transmission for the main load.

The most uncertain figure is generally the cost of the hydraulic privilege. This I shall assume at $20 per h.p. for about 1,500 hydraulic h.p., a rate closely corresponding to various recent sales of medium-sized powers. The electrical station and its equipment may safely be taken at $30,000, and hydraulic development, including wheels, at $40,000. Taking the transmission at, say, 15,000 volts, the line could be put up for about $1,000 per mile, making $50,000 more. Allowing $2,000 for lines and apparatus at each of the twenty distributing points, and a small margin for contingencies, one may say, in round numbers, that the complete installation would not cost more than $200,000. The operating expenses, general expense, and depreciation, including repairs, should not exceed 15 per cent. annually, bringing the annual cost, exclusive of capital charges, to $30,000. Such a plant could carry at least the equivalent of 1,200 h.p. in paying load of lights and motors. At $50 per h.p. per year, this would give a gross income of $60,000, enough to net 15 per cent. on the investment.

Full-load conditions are, however, the exception in cases where


ST.SYMPHORIEN
Grézieux
Boisset
Unias
Cuzieu
l'Hôpital
-le-Grand
ST.GALMIER
St.Médard
Chatelus
Rivas
la Fouillouse
Chevrières
Craintilleux
Chambœuf
Marcenod
Veauchette
Valcon
Aveizieux
Grammont
Vauche
la Gimond
St.Christo
-en-Jarez
St.Romain
-le-puy
Sury
-le-Comte
Routhéon
St.Bonnet
-les-Oules
Fontanes
St.Cyprien
Bourgial
Andrezieux
ST.HÉAND
Bonson
ST.RAMBERT
-S-LOIRE
la Bouillouse
St.Marcellin
St.Just
-s.-Loire
St.Priest
-en-Jarez
la Tour
-en-Jarez
Sorbiers
la Chamba
Villars
la Talaudière
Chambaudière
Cizeron
au Bourg
St.Genest
-Lerpt
Côte
Chaude
Montaud
St.Jean-Bonnefonds
Périgneux
Chambles
St.Victor
Roche
-la-Molière
Bas
Clauzel
Terrenoire
ST.ÉTIENNE
Valbenoite
Aboën
Caloire
la Mar
Unieux
Fraisse
LE CHAMBON
-FEUGEROLLES
Rochetaillée
St.Maurice
-en-Gourgois
la Grange
la Ricamarie
Rozier
-Côtes-d'-Aurec
Fl.
Firminy
Planfoy
Aurec
Chazeau
Tarentaise
Malvalette
St.Ferreol
-d'Aurore
St.Romain
-les-Atheux
St.Just
-Malmont
Loire
Pt.Salomon
Chapelle
-d'Aurec
BAS
ST.DIDIER
-LA-SEAUVE
MONISTROL
-S-LOIRE
Salgotier
la Fressanges
St.Victor
-Malescours
le Monteil
Beauzac
St.Romain
-Lachalme
Pt de Lignon
St.Pal
-de-Mons
Ste.Sigolène
les Villettes
St.Maurice
-de-Lignon
Dunières
COMPAGNIE ÉLECTRIQUE
DE LA LOIRE
MAP OF
DISTRIBUTING SYSTEM
FOR POWER AND LIGHT
LEGEND
Generating Stations of the Company
Overhead Lines
Areas supplied by Transforming Stations
SCALE OF KILOMETRES
0 1 2 3 4 5 6 7 8 9 10

the output is distributed to small customers. In a plant such as we are considering, one is far more likely to get something such a load as at St. Etienne, say 500 h.p. in motors and perhaps five thousand incandescent lamps. Even this means success, since the lamps should yield an income of not far from $25,000 yearly and the motors as much more. Speaking broadly, one can safely count on a good return upon the capital, even with a distribution considerably scattered, if there is, in the aggregate, business enough for a fair total load.

The rate suggested, $50 per h.p. per year, is generally lower than the actual city prices paid for power in the United States by fairly large users. The selling price for electric power from central stations is considerably in excess of this amount, and at $50 per year per h.p. it would pay to shut down even some pretty large steam engines.

Power distribution involving shorter distances than those considered is accomplished still more cheaply, and the price is often reduced considerably below that mentioned. If the market is in one or two towns, so much the better. It is not an easy matter to evaluate the present average cost of power to small users in the United States, but, taking a general view of the conditions, it is probably well within bounds to say that few consumers of 50 h.p. or less can obtain their power for less than 5 cents per h.p. hour actually employed. Until one comes to large factories 2.5 cents per h.p. hour (actual) is below rather than above the mean.

It is clear then that electric power at $50, or even $60, per year, really puts the small consumer in a little town on a level with his larger competitor in the city so far as this consideration is concerned. And while, in the cities themselves, large and small consumers both gain by cheap electric power, the little fellow gains the more conspicuously. In the long run it is to the advantage of those who supply electric power to cultivate the small user, since a price which will neatly square him with a much larger competitor will generally not attract the latter. The big user commonly underestimates the cost of his power more than the small one, and hence is more greedy in driving a bargain. Even the very small user—the chap with a ¼-h.p. motor and half a dozen lights—is never to be despised; he fully realizes the advantage he gains, and is often quite as good pay as larger customers.

The point of the matter most important to the wider view is the fact that electric power can be supplied profitably, in very many instances, at rates which put the small user in the small town on a parity with his larger rivals, aside from the immediate gain that can be made by substituting motors for steam or gas engines. The de-

velopment of water powers gives an opportunity for building up, all over the country, industrial communities that will infuse new life into the dying prosperity of the rural districts. And one of the most curious features of the growth of electric-power transmission, which has made this possible, is the way in which unutilized water powers have come to light in the most unexpected fashion and in the most improbable places. Some one remembers that years ago, before the great western States both raised and ground half the world's grain, there was a grist mill on a back country stream. Its site is looked up after some difficulty and a brief survey develops the fact that reasonable improvements will yield several hundred horse power.

The utilization of such powers is not only a powerful agent for the regeneration of manufactures, but less directly it may be of great benefit in promoting cheap electric-railway service. As has been already pointed out, the rural communities and smaller towns in the United States are severely handicapped in the matter of transportation. Not only do they suffer from being off the main highroads of traffic, but from unjust discrimination in freight rates. Until the iron hand of the government falls, as it should have fallen long ago, upon railways dishonestly managed, four-fifths of the country people will be taxed for the benefit of the other fifth. About the only present defense is the improvement of local means of transportation. Light electric roads, carrying both passengers and freight, are capable of working wonders in this line of progress. Within limited distances they are able both to deliver goods at very low rates themselves, and to work the thumbscrew of competition upon the unwilling hands of the railroads. Aside from these public ends that may be served by electric power, however speedily or slowly they may be reached, there comes the hard, practical, every-day question of economy for the existing small consumer. This, the more common-place side of the subject, we may now properly consider.

Save in rare instances, small amounts of power—say from 50 h.p. down—are derived from steam or gas engines operated on the premises of the user. More rarely power from shafting is rented, or water motors are available. Small steam engines are both inconvenient for occasional use and notoriously inefficient at all times. When operated steadily, they cause a heavy drain upon the coal pile, and, when used intermittently, not only waste fuel but roll up against each h.p. hour furnished a round charge for attendance, interest, depreciation, and repairs. To estimate with precision the average total cost per h.p. is out of the question, but it often reaches $150 per h.p. per year, rarely

falls much below $100 and, where the average output is 10 h.p. or less, not infrequently rises as high as $200. Since most small prime movers are used intermittently and at rather light load, such a yearly estimate of cost puts the case less pertinently than an estimate per h.p. hour, and the figure of 5 cents, already given, is pretty near the truth. In blocks of 25 to 50 h.p. and fairly steady use, it may often be reduced; but, on the other hand, in cases of very intermittent use and in smaller powers 5 cents is often an underestimate. Small gas engines are preferable to steam engines under such circumstances. Oil engines are still cheaper as regards material consumed, but at present practically make up the difference in greater care and depreciation. It is quite certain that the next few years will, thanks to the coming of the automobile, show great improvements in the convenience and economy of small prime movers. Possibly the present cost may be cut squarely in two, but, even so, there will be a wide margin still left for the electric motor.

It has been shown already that, even when handicapped by a somewhat difficult distribution, electrically-transmitted water power can be sold at a profit as low as $50 to $60 per h.p. per year. With the denser service of a good sized town, this figure can be maintained even when the hydraulic costs are higher than those cited.

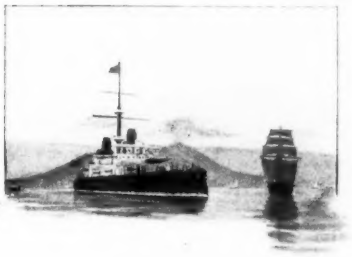
Even when electric power is furnished from a steam plant, these prices could be met if a sufficient load could be assured. Large generating stations can to-day put electrical energy upon their circuits at a total cost somewhat under one cent per h.p. hour. Adding to this the necessary expenses for distribution, there is still a good margin for profit—certainly at the higher price mentioned—if ample load can be obtained. The hydraulic station can work on a smaller scale and afford equal, or better, prices.

The saving between electric-motor service and the cost of power generated in small units, even discounting probable improvements in the latter case, is still material. $20 per h.p. per year is, and always will be, worth saving, and this amount is usually within reach. If, moreover, we look forward a little and bear in mind the elements of future progress and prosperity, the advantages of electric power for small consumers become even more manifest. Urban life demands an abatement of the nuisances caused by innumerable small and large engines within our city limits. With the wholesale use of electric power these can be eliminated—not at increased cost to those who would maintain them, but at a saving large enough and positive enough to be in itself a sufficient reason for the change.

THE DEVELOPMENT OF GERMAN SHIP BUILDING.

By Rudolph Haack.

IV.—THE YARDS FOR THE BUILDING OF RIVER BOATS.



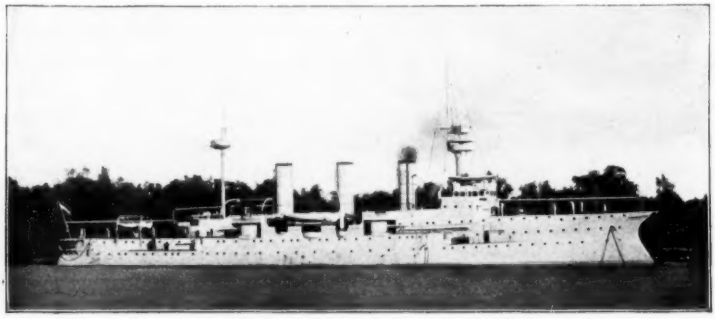
WITH the betterment and increase of navigable inland German waters, there has also been a development and growth in the building of passenger steamers and cargo boats for this traffic, so that to-day it makes up a very important part of German shipbuilding, in which, however, many of the yards situated on or near the sea-coast take part, and this has been mentioned as their output was described. It is, however, the main business of the following yards, situated on the inland rivers; and we begin with the following yards, situated on the inland rivers; and we begin with the Rhine and yard furthest from its mouth, that of the Schiffs-und Maschinenbau-A. G., formerly Schulz Bros. and Bernard Fischer in Mannheim; the business was founded in Mainz, relocated in Mannheim in 1882, and in 1893 taken over by the present joint-stock company. This firm builds steel ships of every kind for the Rhine and its tributaries, and its turnover in 1897 was 1,200,000 mk. The total yards, slips, etc., cover an area of 7½ acres and employment is given at the present time to twelve engineers and three hundred and fifty-four workmen, who in 1898 built eighteen steamers and boats, and still had ten on the ways. The total tonnage was 2,182 gross. Foreign orders for boats came to this yard from Roumania, Switzerland, and Russia, and the largest built had a length of 237 ft. The heaviest engine built was of 250 i. h. p. The repair shops and ways, which can drag out boats up to a length of 295 ft., are steadily occupied. The

Herr Direktor Haack's papers have been remarkable, in that they have presented not only a clear review of the material progress and present status of the ship-building industry in Germany, but with it a very lucid study of the economic and sociological

business is now managed by Mr. R. Blümcke and has a high reputation both with governments and shipping firms, from whom its chief orders come.

The largest yards on the Rhine are those of the firm Chr. Ruthof, in Castel, which builds mainly boats for the Rhine and, including boats still on the ways, it turned out in 1898 twenty-four boats of 10,534 gross tonnage. Of these, however, only two were steamers, with engines of a total of 700 i. h. p.

Further down the Rhine, in Coblence, the firm of Schaubach and Grämer built only one steel boat of 331 gross tons registry, but the next firm, that of E. Berninghaus in Duisburg, built twenty-two boats of 6,041 gross tons. The Meidericher Schiffswerft in Meiderich



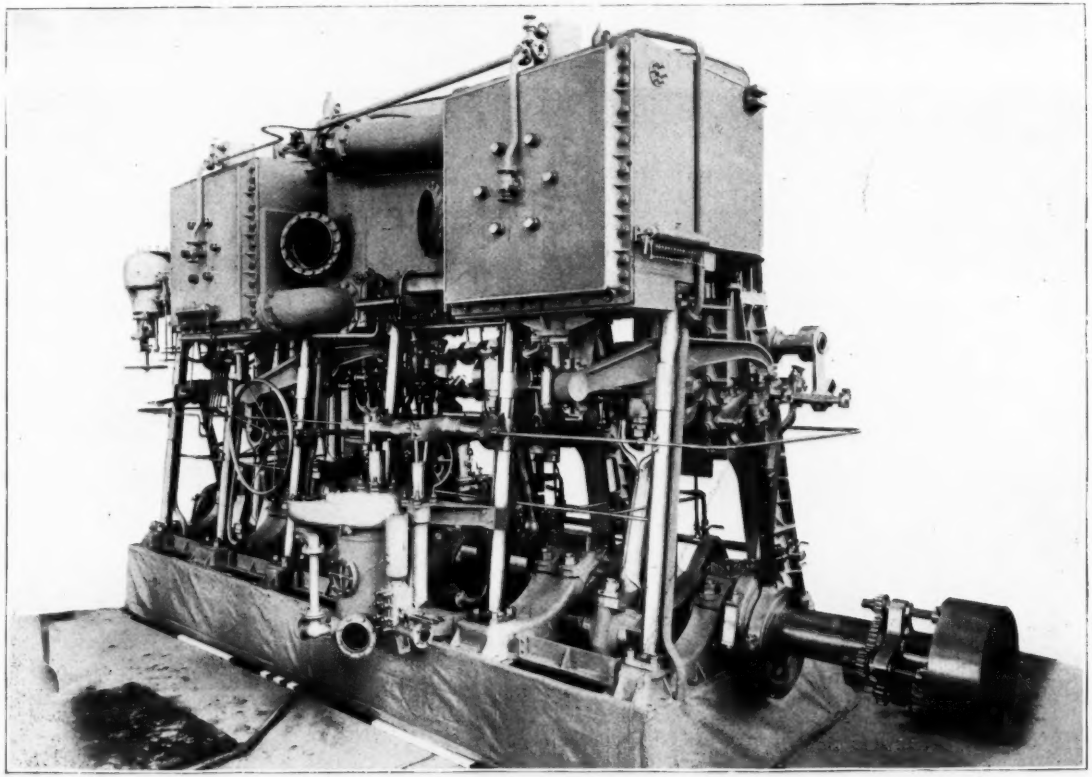
GERMAN CRUISER HERTHA, SECOND CLASS.

344½ x 57 x 37 ft.; 5,630 tons, 10,000 i. h. p., 19½ knots. Built at Stettin, 1897-98.

built 536 gross tons, and the yards of the Dortmunder Union Act. Ges. für Bergbau, Eisen-und Stahl-Industrie, at Dortmund, which did its first work in 1898, built six boats of a total of 840 gross tons.

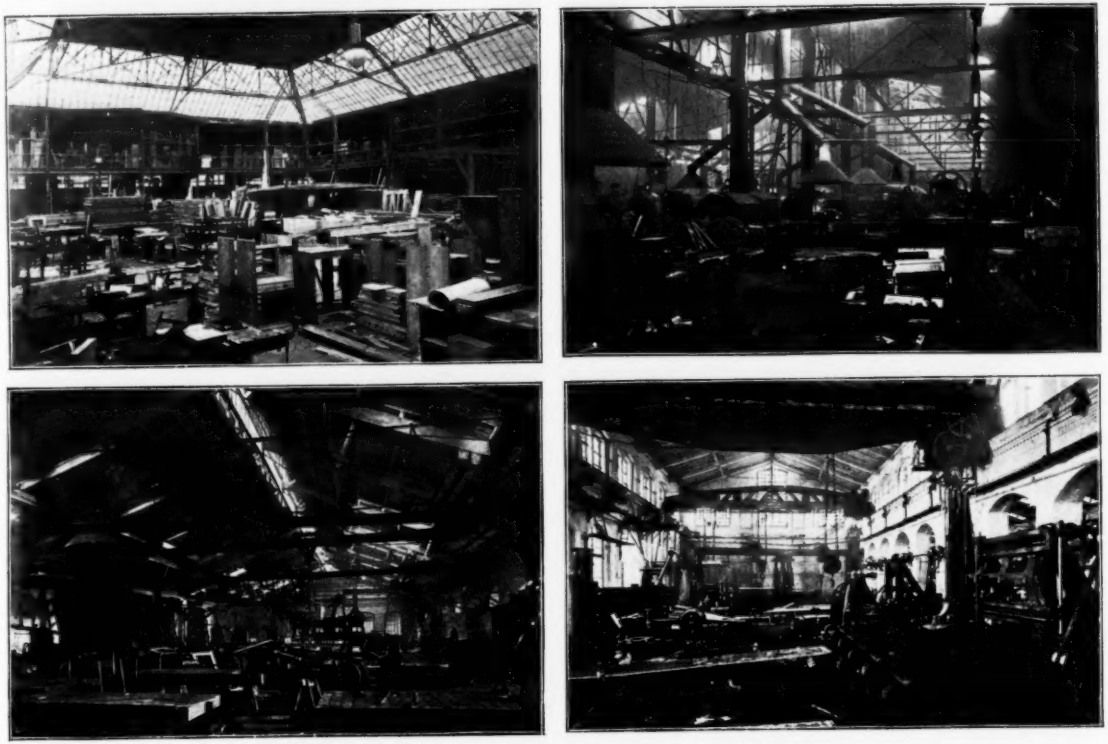
There is much activity on the Elbe also in the building of river boats, and in 1898 the Dampfschiff-und Maschinenbau-Anstalt der Oesterreichischen Nordwest-Dampfschiffahrts-Gesellschaft in Dresden built ten steamers and tugboats, with a total gross tonnage of 2,914 and the "Kette," Deutsche Elbschifffahrts-Gesellschaft, in Uebigau near Dresden, built twenty-one boats with a total gross tonnage of 3,689. Especial mention should finally and at the end of the list be given to the yard of Gebrüder Sachsenberg Ges. m. b. H. in Rosslau-

influences under which this industry has been developed. The concluding article of the series, in this issue of THE ENGINEERING MAGAZINE, is a brilliant example of Herr Haack's style and method. It epitomises the history of German marine and naval engineering—a branch of work which itself includes almost every line of engineering activity. THE EDITORS.



ONE OF THE THREE FOUR-CYLINDER TRIPLE-EXPANSION ENGINES OF THE GERMAN CRUISER HERTHA.

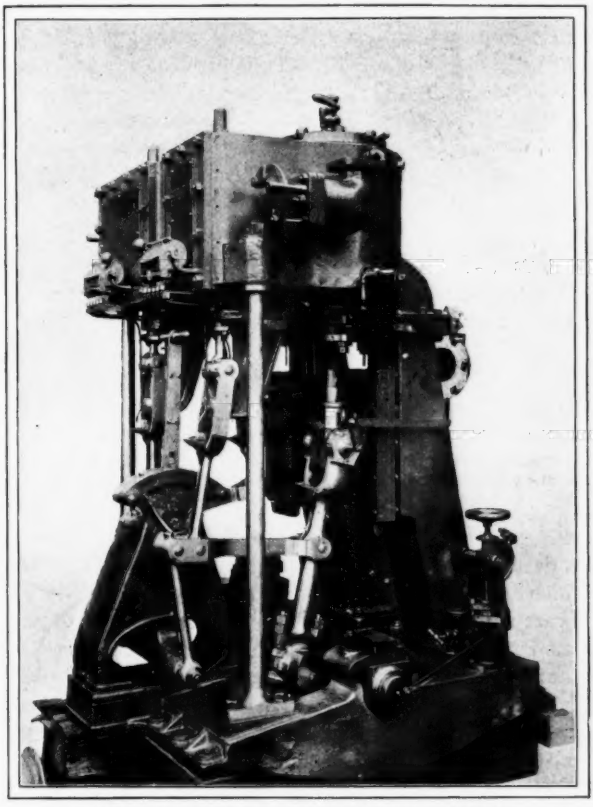
10,020 i. h. p. Schlick counterbalancing system. Built at the Vulcan Works.



FOUR VIEWS OF THE INTERIOR OF THE VULCAN WORKS AT STETTIN.

Wood-Working Shop.
Forge Shop for Frames.
Marine Forge Shop.
Armour-Plate Shop.

an-der-Elbe, which was founded in 1868 by Messrs. Gottfried, Friedrich, und Wilhelm Sachsenberg, who had been running a machine shop since 1844. Up to 1888 this firm built wooden vessels, and later iron and steel boats. The yards cover an area of about 55 acres, and



COMPOUND MARINE ENGINE FOR A SMALL STEAMER.

$\frac{250}{500} \times \frac{450}{}$ millimeters; 125 i. h. p.; built by the Mannheim Ship and Engine Building Co.

the company builds passenger steamers, cargo boats, tug-boats, etc., for rivers, canals and coast trade, and also stationary engines, boilers, brick-making machinery, shot towers, distilling apparatus and machinery, paper-mill machinery, etc. Owing to location of the yards on the lively Elbe there is a constant demand for repair work, and

traction ways for river boats are suitably installed and almost always occupied.

Last year this firm employed one thousand workmen and the seven completed boats and the five still on the ways amounted to a

ELEVATOR FOR HANDLING AND DISCHARGING DREDGED MATERIAL.
The conveyor takes the spoil from scows or barges and delivers it onto the bank or into waggons. Capacity, 130 cu. yds. per hour; requires 60-65 h. p. Constructed to take down for transportation overland. Built at Mannheim.

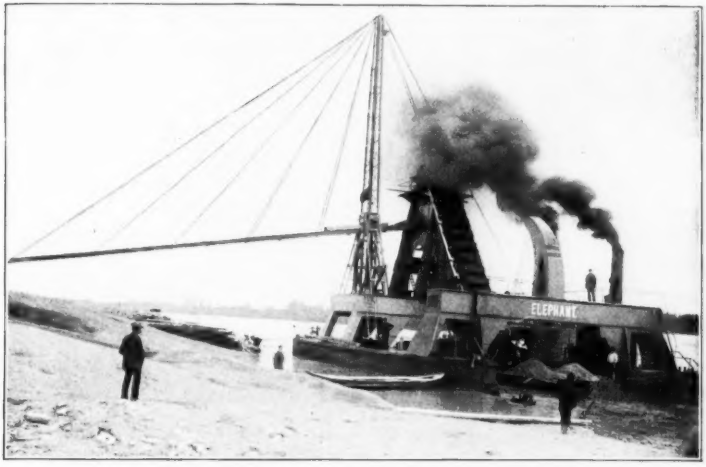
total of 4,741 gross tons, with engines of 6,250 i. h. p.; one steamboat was destined for the Rhine and another for Bolivia. This company, which builds all its boats and executes all its work with the greatest care and skill, deserves great credit for its improvements in river boats and especially in their engines and machinery.

All the German yards were busy in the year 1898 with the building of five hundred and twenty-eight vessels of 546,461 gross registered tons, of which three hundred and thirty-three, of 208,835 gross registered tons, were completed and, at the end of December, 1898, one hundred and ninety-five vessels of 337,626 gross registered tons still unfinished. There is, therefore, certainty of greatly-increased tonnage during the current year, especially as orders are pouring in more numerously than ever before. The total cash turnover of all the yards of Germany for 1897, including those whose official figures we have given and an estimate for the others, amounts in round numbers to 120,000,000 mk., an important figure which in 1899 will be very markedly larger.

From the short description of the several yards and plants on sea-

coasts and rivers it is seen that nearly all of them manufacture other things not directly connected with ship-building and marine engines. When the building of iron and steel ships first began, this activity and skill in other directions was of the greatest advantage; for without this outside source of revenue in the period before 1890 many of the enterprises would have suffered great pecuniary embarrassment, if indeed they had not failed entirely. Nevertheless, most of the plants were founded for ship-building only, and will continue to exist for it. How long a time and to what extent the auxiliary business will be kept up cannot now be determined.

There is no uniformity in the relative number of staff and workmen employed, tonnage delivered, and indicated horse power of engines. No accurate comparison in this respect is possible, because the kind of work and the manner of its execution varies so much. In general, there is relatively a larger staff of engineers and employees in the yards where battle ships and the large fast passenger steamers are



CATAMARAN ELEVATOR FOR HANDLING DREDGED MATERIAL.

Capacity, 2,750 cu. yds. per hour; 90 i. h. p. The spoil is taken from the barge and delivered on shore through a spout or by a belt conveyor. Built at Mannheim.

built, because these make bigger demands on intelligence and trained skill. The average of wages varies with the locality in which the yards are situated. Wages are highest in the great sea-ports of the North Sea, and lowest in the more easterly cities and towns of the Baltic;

but wages are rising everywhere. Many of the great companies not only do what is required by law for the disabled and sick, but voluntarily ameliorate, so far as they can, the condition of the workmen and their families, in the matter of educational and hygienic facilities. Many of them provide good dwellings on favourable terms, or organise sick- and relief-funds, co-operative stores, etc., take care of those who are needy, and look after the requirements of hygiene; and at the Sunday and night schools, especially for the younger workmen, opportunity is afforded to take elementary courses in mathematics, drawing, and other studies, so that these men may fit themselves to take positions later in erecting work, as foremen, and even as draughtsmen in the offices.

FLOTILLA OF THREE STEAM LAUNCHES AND TWO STEAM DREDGES.

Built for the Dortmund Ems Canal by the Mannheim Ship and Engine Building Co.

Next to the mental, physical, and moral welfare of a body of trained and skilful workmen, a suitable and adequate supply of raw materials for ship-building is most important. Its quality is the very basis of the excellence and duration of the hull of the ship, and its prompt delivery, in proper sequence, is absolutely essential in all contract work with specified time of delivery. The German sources for all timber used for earlier ships has already been mentioned, but all iron, and later all steel, had at first to be brought from Great Britain. German furnaces and mills were not prepared for this kind of work; they had no rolls for the many cross-sections, and the raw materials were too costly to enter into competition with the cheap British iron supplies for ship-building, especially as these were all admitted duty free, in order to give German builders a chance to compete. The same conditions continued to prevail even for a long time after the introduction of steel for ship-building, and several attempts were fruitlessly made to mend this state of affairs by some kind of union or agreement between ship yards and rolling millls. Plates could, indeed, be rolled, but angle irons and beams, such as ship-building required, could neither be manufactured nor supplied. The very limited demand for

materials was not encouraging for the equipment of shops with the rolls necessary to supply all the cross-sections required by the many different types of ships. Little by little progress was made, and the real start is to be recorded from the date when the German navy began to build iron-clads and the Imperial Government subsidised mail steamers, to be built of German material; but very slowly did the mills install the necessary machinery to supply some of the required cross-sections. Very recently the iron mills have entered into a combination, with a central office, and to this all inquiries and orders for the whole of the ship-building supplies are sent, and in this manner every demand can be filled and the work is subdivided according to the equipment, facilities, and specialties of the several millls.

STEAM LAUNCH FOR THE DORTMUND-EMS CANAL.

41.2 x 10 ft., 30 i. h. p. Speed, 9 miles an hour. Built by the Schiffs- & Maschinenbau-Akt.-Ges., Mannheim.

The difficulty has not even yet been wholly remedied, and quite an important volume of the orders for ship-building materials still go to England, and especially from those yards most distant from the iron centers, where the increased cost of land carriage over water transportation makes it too expensive to draw supplies from the inland German iron works in Westphalia or Silesia. Moreover, the yards could not afford to pay higher prices for steel when (and this was often the case), they were competing with British firms for orders to build cheap freighters. Therefore,

GOVERNMENT INSPECTION AND TOWING STEAMER.

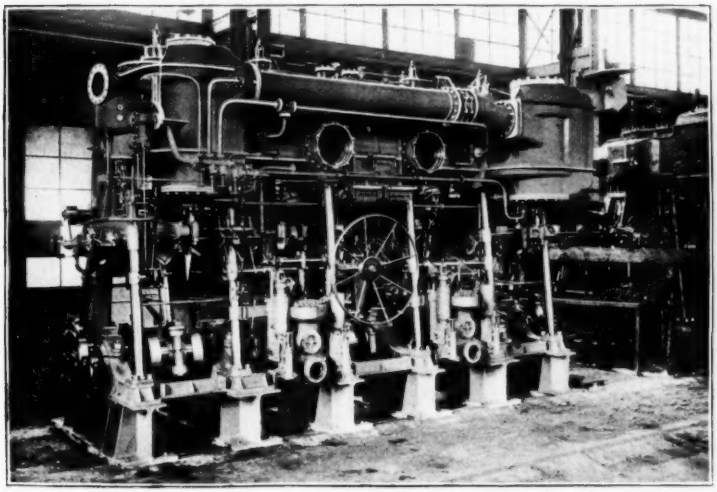
66 x 13.2 x 5 ft., 125 i. h. p. Built by the Mannheim Ship and Engine Building Co

unfortunately, all ship-building material used in building German vessels is not yet of exclusively German origin, but this condition will not last much longer.

The above-described condition of affairs, as well as the recent overflow of orders and surplus of work in all German yards, has made it possible for certain shipping firms to order vessels in England and Holland. Including the vessels still on the ways on January 1st, 1899, not less than fifty-seven ships with a total gross tonnage of 103,176 tons were building abroad for German account. This is 18 per cent. of the total tonnage built in Germany, and in this total are included all foreign orders for German work. Foreign building of vessels for German account will soon cease, for, owing to the rapid increase in size and number of the ship-building yards, all vessels required will be supplied at home and the steps taken by the iron and steel manufacturers, as already described, will make the profitable import of British material unnecessary, if not inadvisable.

The Ministry of Public Works (which controls the state railways) intends to issue a special and exceptionally low tariff for the economical transportation of iron and steel material for the building of ocean and river craft, so as to facilitate the use of home supplies, especially by those yards most distant from the iron centers. German ship-

ERECTING SHOP, VULCAN WORKS, STETTIN.



FOUR-CYLINDER TRIPLE-EXPANSION ENGINE FOR 3,000-TON CRUISER.
7,500 i. h. p. Built at Stettin, 1897-98.

building is already self-sufficient and independent in the production of the largest forgings and castings for stern and bows, and for parts of machinery. They are supplied by Krupp of Essen and by others, and are of superior workmanship and wholly satisfactory. This is particularly true of the cast-steel shafts of every kind, these being splendidly made at Bochum. Armour-plate was first secured entirely from Sheffield, then made in Germany first by the Dillinger Hütte, in Dillinger a/S., and more recently, and of the highest grade, by Krupp, according to his own patents. This patent, indeed, has been purchased by all foreign plants which make a specialty of armour plate.

The large and luxurious passenger steamers of the North German Lloyd, which were built in Great Britain, were also equipped and finished there in all their interior work. For some of the later steamers, the interior designs were supplied by Architect Poppe of Bremen, but for the "Lahn" all the joiners and cabinet work, and the painting and decorations for the saloons were completed in Germany, shipped to Glasgow, and built into the ship by German workmen. The Imperial mail steamers and the recent fast German passenger steamers have been fitted up with constantly increasing richness and luxuriousness, and this has developed a new industry which supplies ex-

cellent results from the designs of its own specialists, architects, and artists. Nearly every kind of larger equipment, for which British firms had gained a great reputation, and which was accordingly specified by the German shipping firms for whose account the vessels were building, was formerly delivered in the German yards; but, little by little, this industry has also passed to German manufacturers, who now supply steam capstans and cargo winches, steam steering gear, anchors and chains, etc., unless British articles have been specifically ordered. Many of the German specialties have already surpassed any-

IRON-FRAME CONSTRUCTION FOR AN ERECTING SHOP.

148 x 142 ft. Built by the Schiffs- & Maschinenbau-Aktien-Gesellschaft, Mannheim.

thing made in Great Britain of the same kind, as, for example, the hydraulic discharging and loading appliances and apparatus of C. Hoppe in Berlin, which have recently been introduced in the latest big freighters of the North German Lloyd; another example is afforded by the steam ranges and emigrant galley equipments of Becker & Ullmann in Berlin, which have even been sent to England for the cutfitting of vessels built in England for German account. In this same line are the life boats built by O. Kirchhof, in Stralsund, for big passenger steamers, etc. Also nautical instruments, such as chronom-

eters and compasses, are supplied by the opticians and specialists of Berlin, Hamburg, and Bremen, of such perfection that, according to the verdict of the Imperial Naval Testing Bureau in Hamburg, captains who formerly would have nothing but British manufactures now prefer the German articles. To mention all these articles would take too long, but it is sufficient to say that all are now made in Germany, and with few exceptions, are not now imported from England, except when certain articles are specially so ordered by captains or shipping firms.

ONE SPAN OF THE LINDENHOF BRIDGE AT MANNHEIM.

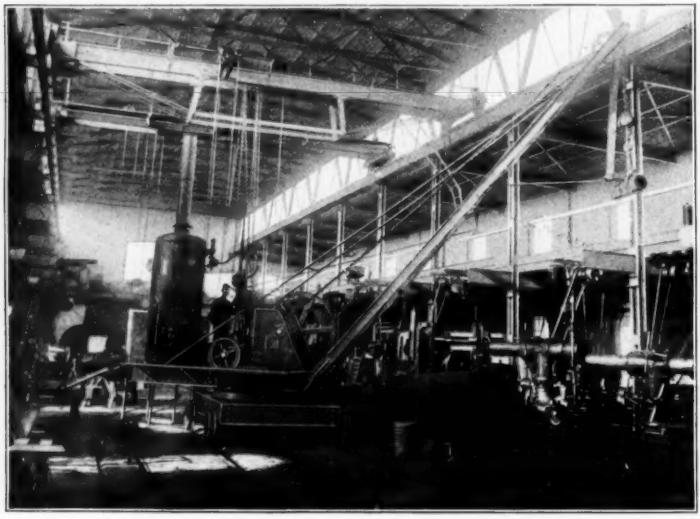
Another example of the range of work done in German ship-yards. The bridge is about 46 ft. wide, with spans of about 150 ft. Built by the Schiffs- & Maschinenbau-Aktien-Gesellschaft, Mannheim.

The inspection of merchant vessels during building, and afterwards during commission, in the interests of the insurance companies, has been undertaken in Germany for all German-built sailing vessels by the Bureau Veritas ever since its incorporation in 1828, and the requirements of this bureau were considered standard. Lloyd's Register was also occasionally made use of, and the German Lloyd organised in Germany for the same purpose could for a long time gain the confidence neither of insurance companies nor of ship owners. The building of the Imperial mail steamers was of the greatest importance

for this institute, since the Imperial Chancellor Prince Bismarck ordered, in 1885, that these ships should be classed and registered in a German registry, and the only concern that could do this was the German Lloyd. In this manner it acquired some reputation with big ship owners, and others followed, so that to-day its registry has grown to a very important list.

The institute is well directed by its managers, at present Messrs. Ulrich and Middendorf, and its representatives, agents, and examiners are located in all of the larger harbours of the world, while in the iron regions it supervises the tests of iron and steel intended for ship-building purposes.

The German Lloyd has moreover been charged by the See-Berufs-genossenschaft (Sea-farers Union) with technical supervision over that part of the outfitting and equipping of vessels which may affect the health or lives of the crew, and the supervision is most beneficent,



STEAM JIB-CRANE OF 7-METRES RADIUS AND 4-TONS CAPACITY.
Installed in the erecting shop of the Mannheim ship-yards.

as it preserves the sailor to the highest degree possible from those dangers which are so peculiar to, and universal in, his hard calling.

All these regulations and economic provisions, briefly enumerated and described, have helped to develop German shipping in-

terests, and have succeeded in making it independent of all other nations. There has been also a constant and general co-operation between the German and foreign ship-builders, taking the form of the exchange of experience and knowledge, as well as of direct con-

DREDGE AND EXCAVATOR FOR REMOVING ROCK.
Built in Mannheim for the regulation of the river Main.

sultation and acquaintance of the specialists with one another, and of the founding of periodical literature, which is well established and constantly growing. Thus, the German naval constructors and mechanical engineers are no longer mere absorbers, as formerly, but they give as well as take. In this manner the way is prepared for international co-operation, which will surely lead to the highest pinnacle of perfection.

All these details which have been enumerated at such length are the general answers to the qustion with which these articles opened; but perhaps it is well again to point out the main influences. On the one hand it is plainly to be perceived that the rapid and important development of ship-building in Germany is to be credited chiefly to the scientific training which the men, to-day in charge of it, had the favourable opportunity of acquiring. The study of the yards, plants, and practice abroad, especially in England, laid the foundation, and on

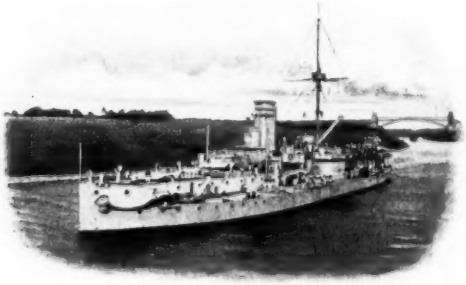
this they built further by their own diligence and upright persistence, being mightily helped to reach the present height by the abundant facilities of the technical high schools.

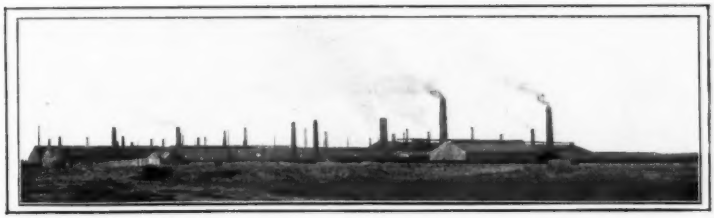
On the other hand, one sees from the description of the various yards that here has been everywhere intense individual enterprise and energy; that the managers have worked hard, using every fair means to secure orders and to execute them with an eye to the future; as also that, during the period of apprenticeship, less attention was paid to present gain than to lasting reputation for splendid ships and engines.

Finally, all worked to attain the one great end. The Imperial Government helped the development by its own orders, its regulations and provisions for the home-built German ships, and by instructions to its representatives abroad to recommend on all occasions not only general German manufacturers but especially German-built ships, and, when occasion occurred, to help German firms, so far as its power reached, to secure contracts and to close deals.

All these endeavours and exertions were supported, and in the most active way fostered, by the intense interest which His Majesty the German Emperor manifests in everything belonging to the sea and German ship-building. Every new success is officially recognised and every worthy achievement is personally praised by him.

Let us close by wishing that international rivalry in ship-building may be yet further stimulated, to the furtherance of the ship-builder's art and the prosperity of nations. All naval engineers and mechanical engineers must endeavour to surpass one another in this respect. Germany, however, will never again lose the high position she has by her own efforts gained.





Boston and Colorado Smelter, Denver

THE EVOLUTION OF MINING AND ORE TREATMENT IN COLORADO.

By Thomas Tonge.

THE history of mining and ore treatment in Colorado, more particularly in recent years, is a remarkable instance of evolution of all lines. The chairman of a well-known London mining syndicate, which operates in various parts of the world, notably South Africa and West Australia, not long ago visited Colorado for the first time and, prior to leaving, informed me that he had not before realized the progress made and the great advantages possessed by Colorado in all the important factors of successful and profitable mining, such as transportation and ore-treatment facilities, effective inventions, appliances and methods and, last but not least, the skill and efficiency of the professional and practical men engaged.

Gold was first discovered in Colorado in 1859, but the district was then over 700 miles west of the nearest railroad, the intervening plains being infested by predatory Indians. It was not until 1870 that the first railroad, the Kansas Pacific, reached Denver. To-day, there are already over 5,000 miles of railroad within the boundary lines of Colorado and more are being constructed.

As the mining districts range from 8,000 to upwards of 13,000 feet above sea level, the railroads have had to overcome great engineering difficulties, as will be readily understood when it is stated that the Colorado Southern Railroad crosses the Continental Divide at Alpine Tunnel, at an altitude of 11,596 feet (the highest railroad point in America, except the railroad up Pike's Peak) and at Boreas at 11,470 feet. The Denver & Rio Grande Railroad at Fremont Pass is 11,328 feet and at Marshall Pass is 10,852 feet, and the Colorado Midland Railroad at the Busk-Ivanhoe Tunnel is 11,028 feet above sea level.

In recent years there has been a general reduction of railroad

freight rates, on all smelting ore and concentrates, of from 25 to 50 per cent. So large a reduction in freight rates has naturally given a great impetus to the mining and has resulted in a vast increase of tonnage, notably of low-grade ores.

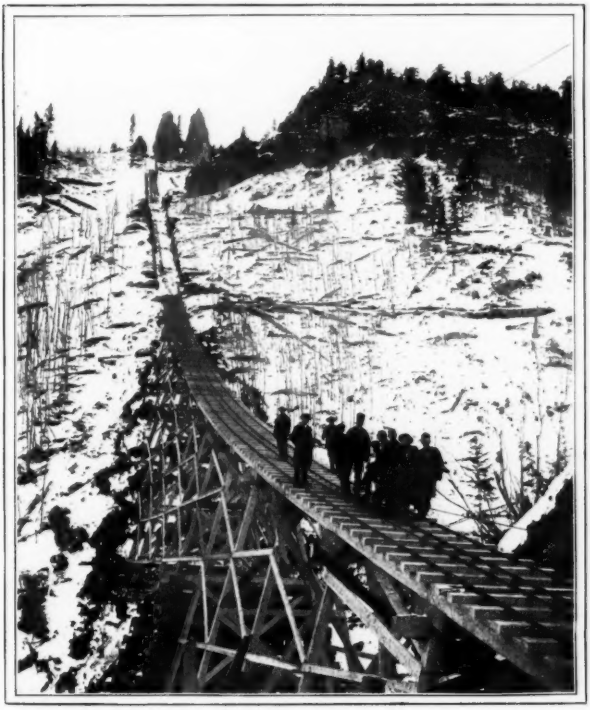
Supplementing the railroad facilities, hundreds of miles of wagon roads have been built connecting mines with the railroads, in many cases in place of the older trails for pack animals. In the case of comparatively short distances, where wagon roads were not feasible, in many cases aerial wire tramways (of which there are now dozens in the State), in other cases tunnels, and in still other cases, a combination of tunnel and tramway, have also taken the place of pack animals. One instance among many of the saving in cost thereby effected is found at the Smuggler-Union Group near Telluride, San Miguel County, where formerly all supplies had to be conveyed to the mine, and the ore carried down from the mine, on donkeys' backs and by a steep, narrow trail. This involved a total cost of $5 per ton on all the ore extracted. To-day, by means of a shaft, tunnel, and two tramways, each a mile in length, the same service is performed at a gross cost of less than 50 cents per ton of ore.

Numerous mining tunnels such as the Cowenhoven Tunnel at Aspen, the Revenue Tunnel near Ouray and others,* have effected great economy in operation, and, as a consequence, admitted of the mining and treatment of lower-grade ore at a profit.

TYPICAL WAGON ROAD IN THE ROCKY MOUNTAINS.

In the pre-railroad days, when Colorado was largely virgin ground, placer mining was practically the leading industry. A con-

* These tunnels were described in "Some Important Mining Tunnels in Colorado," published in THE ENGINEERING MAGAZINE February, 1897.



TRAMWAY AT SMUGGLER-UNION GROUP, NEAR TELLURIDE.

servative estimate places at not less than $25,000,000 the value of the gold taken out of the placers of the streams in Colorado during the decade 1860-1870, the work being done by primitive "rockers," "short sluice boxes" and hand labor. After 1870 increased attention was given to lode mining, and placer mining was correspondingly neglected—all the more readily because, in many places, the very rich ground which alone could be profitably worked by crude methods and manual labor had been practically exhausted.

Within the last few years, however, placer mining in Colorado has entered upon a new era. Companies have entered with large capital, employing eminent engineers, using expensive hydraulic appliances and floating dredges; various patented "elevators" are also being utilized to overcome the difficulties, where there is not sufficient natural fall for the deposition of the "tailings" by gravity.

ALPINE TUNNEL, COLORADO SOUTHERN RAILROAD.
The highest railroad point in America. Altitude, 11,596 ft.

The gold ore first discovered in 1859 in veins or lodes in Colorado's pioneer mining district—Gilpin County—was "free milling"—readily extracted by the comparatively crude methods of arrastras and stamp and amalgamating mills of from five to ten stamps each. These were

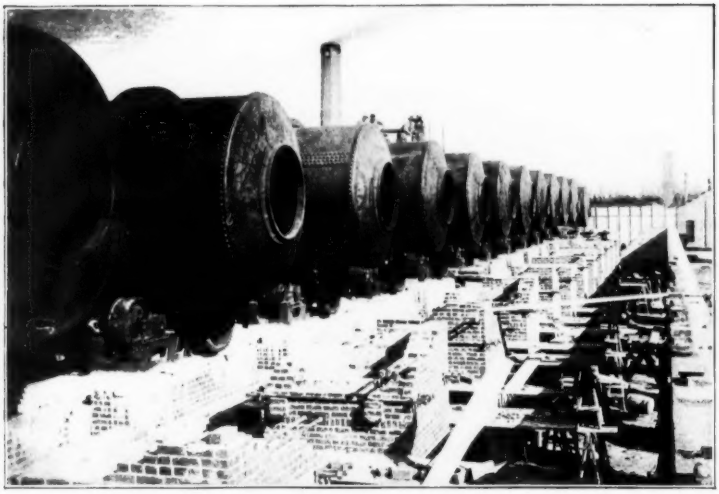
AERIAL TRAMWAY BETWEEN MINE AND MILL.
950 feet span; buckets 450 feet above the ground.

operated either by steam or water power, all the machinery being brought in wagons 600 miles across the plains. As depth was gained on the veins, the decomposed or oxidized ore was succeeded by ore of a refractory character, from which the stamp mills could only extract a small percentage of the known values; the bulk of the ore, though rich in gold, passed over the amalgam plates down through the sluices into the bed of the creek, being thereby lost. Even if the concentrates could have been saved, there was then no known process by which the gold contents could be extracted at a profit. From 1864 to 1867 numerous attempts were made to solve this problem, so vital to the district, but without success, and their failure brought the local mining industry to the verge of despair.

THE COLORADO-PHILADELPHIA CHLORINATION MILL, COLORADO CITY.

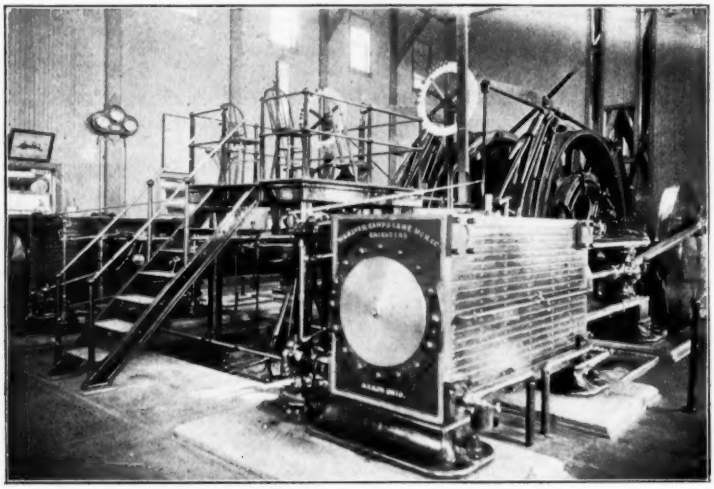
In 1867 there was erected at Black Hawk, Gilpin County, a smelting plant of 12-tons' daily capacity, consisting of one reverberatory and one calcining furnace, with the requisite machinery for crushing, pulverizing, etc. It commenced operations in January, 1868, and proved a success. The result was that the miners, finding a ready cash market for their ore, began to operate their abandoned claims and the mining industry of Colorado commenced a career which has ever since increased in magnitude and importance.

As illustrating the local conditions at the time of the commencement of operations by this pioneer smelter, it may be stated that every single fire-brick used in its construction cost one dollar, having to be brought by wagon about 600 miles from the nearest point on the Missouri River, and to that point by railroad from St. Louis; the iron cost 22 cents per pound; the pay of skilled labor was $8 per day, and of common labor $4 per day; and the charge for smelting ranged from



ROASTERS AT DENVER SMELTER.

Each smelter is 28 feet long by 8½ feet diameter, and takes a charge of 25 tons, nominal.

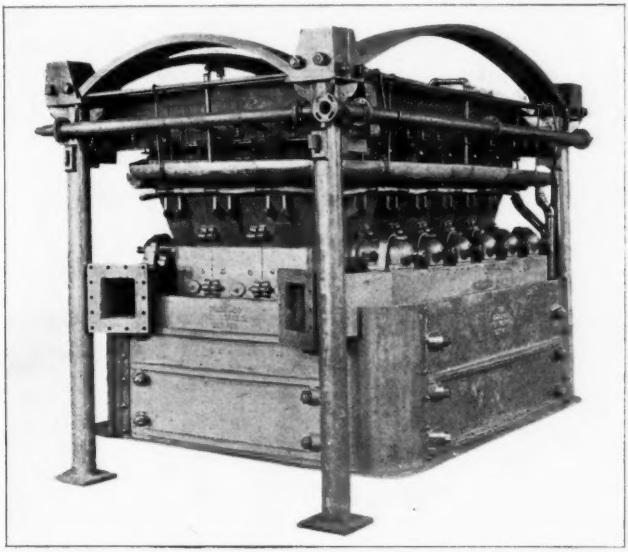


HOISTING PLANT OF THE GEYSER MINE, CUSTER COUNTY, COL.

The mine is 2,650 feet deep.

$20 to $45 per ton. There was no railroad nearer than the Missouri River, about 600 miles away; wagon transportation was high, as also were all the necessaries of life. Moreover, the "matte," the product of the plant, in the absence of any local means of separating or refining, had to be hauled to the Missouri River in wagons, thence by railroad to New York, and thence to Swansea, Wales, where it was separated and the gold, silver, and copper refined.

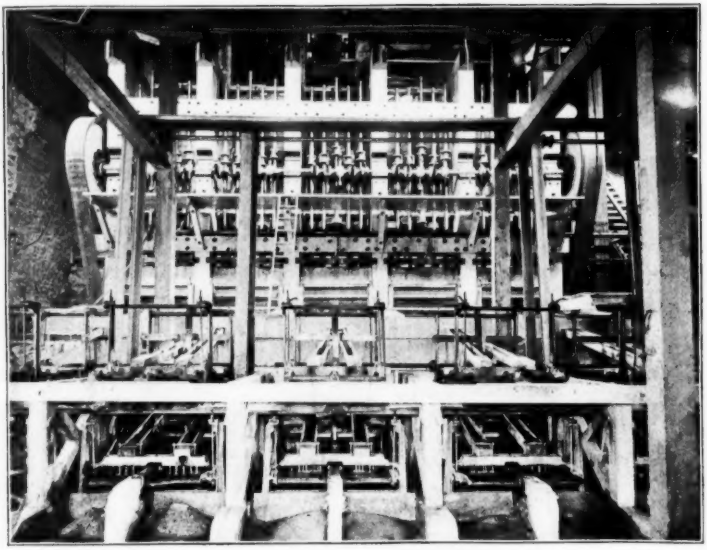
To-day, there are nine smelting plants in Colorado, viz., three in Denver, three in Pueblo, two in Leadville, and one in Durango, besides a zinc-lead smelter in Cañon City. Two of the plants refine



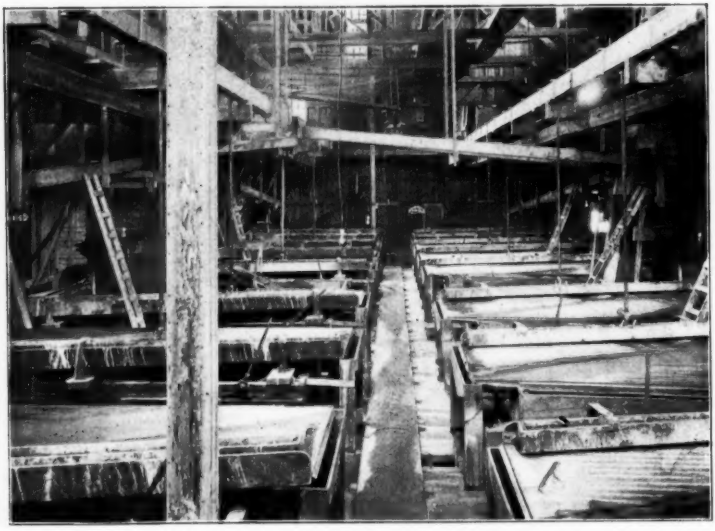
SMELTING FURNACE MADE IN DENVER AND EXPORTED TO THE ISLAND OF CELEBES, EAST INDIES.

their product, selling the gold to the Denver mint; the others ship their matte to allied eastern refineries. The aggregate daily capacity of the existing smelters is 4,500 tons and about 4,000 men are employed. Some of the plants are about to be materially increased in size and capacity, and new plants, including pyritic smelters, are in contemplation to meet the increased production, more particularly of low grade ores.

To state it concisely: whereas, in 1871, after paying the cost of smelting, etc., the miner only received 65 per cent. of the value of the



STAMPS AND PLATES IN A COLORADO MILL.



MODERN CONCENTRATION TABLES.

ore, by the year 1889 he received 84 per cent. of the value, and the percentage has since been somewhat further increased. The average smelting charges in 1868 were at least $30 per ton, as against an average of about $4 per ton at the present time. In 1878 the average value of the ore treated in Colorado had to be about $100 per ton to leave a profit, as against the average value in 1899 of $25 per ton, including concentrates representing original crude ore reduced from six or seven tons to one ton.

The great improvements in smelting and the reduced charges have given a great impetus to other phases of ore treatment and to mining in general. There has been great improvement in the stamp mills also. A fifteen-stamp mill of to-day, with shallow mortars and rapid drop, treats more ore than the sixty-stamp mill, with deep mortars and slow drop, of the type which was in vogue in the "sixties." The usual capacity of the old-fashioned stamp mill was about one ton of ore per day per stamp, as they were then solely dependent on the stamp mill for the recovery of the gold values. The usual capacity of the modern stamp mill is from three to four tons of ore per day per stamp, the method being, (1) :—to catch all the gold possible on the plates; (2) :—to catch the maximum of the remaining gold on concentrating tables succeeding the stamps and plates; (3) :—to ship the concentrates to the smelters.

At the Perigo Mine, Gilpin County, ore averaging as low as $3 per ton is mined and treated at a profit by means of a thirty-stamp mill, which saves a large percentage of the value, the tailings being concentrated and the concentrates shipped to the smelters. In Gilpin County alone there are thirty stamp mills containing a total of nearly one thousand stamps. In the vicinity of Telluride, San Miguel County, there are several large mills of one hundred stamps and upwards each. For some classes of ore, such as lead-silver ores, crushing rolls have superseded the stamp mill. Their superiority lies in not pulverising the ore too fine, and in reducing without "sliming;" the "slimes" resulting from stamping these ores carry off the values.

For every ton of ore rich enough to pay the cost of mining, wagon haul, railroad freight, and smelting charge and still leave a profit, there are at the very least ten tons of lower-grade ore, which could only be so treated at a decided loss, great or small. Such lower-grade ore is therefore concentrated, and in no branch of the mining industry in Colorado has greater progress been made, especially in recent years, than in concentration. The result is that an immense tonnage, formerly outside the range of profitable handling, is

now being treated at a steady margin of profit. One instance among many may be mentioned. At Silverton a large concentrating mill is treating, at a comparatively handsome profit, crude ore the average gross value of which in gold, silver, lead, and copper does not exceed $5 per ton. This is not a mere by-product, but is the general character of by far the greater portion of the product of the mine. In this case, from four to seven tons of crude ore are reduced to one ton of concentrates, in which process less than 10 per cent. of the value is lost, the objectionable zinc is largely eliminated, the resulting concentrates carry an excess of iron (for which the smelter pays a premium), and, as the mine is within fifty miles by railroad from a smelter and a reasonable freight rate prevails, the concentrates are marketed at a substantial profit.

Generally speaking, ten years ago the highest saving of the values in sulphide ores by means of concentration was from 50 to 75 per cent., but at the present time it is as high as 90 per cent. By means of concentration, at many points in the State, large dumps of old mines and tailings of old mills, which accumulated during the last twenty or thirty years when no means existed for the profitable treatment of low-grade ore, are now being handled at substantial margin of profit, as also are large bodies of low-grade ore in the mines, formerly ignored for the same reason. The recent annual increase in the Colorado production of the precious and allied metals is owing, in no small degree, to the vast tonnage of low-grade ores rendered available by improved concentrating machinery and methods, operated at the minimum of cost and effecting the maximum of saving. In Clear Creek County alone, for the ores that do not go directly to the smelters, there are thirty-four plants for concentration and amalgamation.

Another important factor in the evolution of Colorado mining, as yet practically confined to the Cripple Creek district, has been the local establishment of cyanide and chlorination plants for the treatment of the lower-grade tellurium ores. The present condition of affairs is that all Cripple Creek ore worth $40 per ton and upwards goes to the smelters at Denver and Pueblo, being treated at a charge of from $10 to $14 per ton, $20 per ounce being paid for the gold. The ore ranging in value from $10 to $40 per ton goes to the cyanide and chlorination plants at Florence and Colorado City, the treating charge ranging from $6 to $10 per ton. All ore averaging in value less than $10 per ton—of which many thousands of tons have been produced in the course of mining richer ore, and now form great dumps, and of which much larger quantities remain in the

mines—is not yet within the range of profitable treatment by any existing plant and awaits the advent of some new process.

Another important factor of the last few years has been the utilization of the mountain streams, in some cases, and of cheap fuel in others, for the generation of electricity and the utilization of such electricity for power and lighting purposes, at mines at so high altitudes and accessible only by trails or wagon roads so steep as unavoidably make fuel for steam power at such mines almost prohibitive. The Silver Lake group near Silverton is at an altitude of from 12,000 to upwards of 13,000 feet. The waters of a mountain stream are used in a three-phase power plant at an altitude of about 9,000 feet to generate 400 h.p., which is transmitted by wire 11,000 feet and 22,000 feet respectively to the mines, and there runs seventeen motors occupied in various kinds of work, ranging from 1 h.p. to 100 h.p. each. But for this comparatively cheap power the production of the mine would be restricted.

Another factor, equally important, has been the utilization of compressed air for the operation of machine drills and the great improvement in the drills themselves. The earlier type of machine drill would do as much work as five or six men using hand drills, but the more recent types of drill do this and more, at a saving of 50 per cent. in fuel, as against their predecessors. Several hundreds of the latest-made drills have gone into use within the last eighteen months. The diamond drill is another comparatively recent auxiliary of the mining industry, being utilized for prospecting purposes at a fraction of the expense of sinking a shaft to a similar depth. In a recent case it was most successfully and economically used to tap, from a tunnel, the flooded lower workings of deep surface shafts, which the tunnel was designed to cut for more economical future mining operations.

Most marked also have been the improvements in hoisting plants from the primitive hand windlass, horse-whim, and small engines of years ago up to the latest and most modern machinery, operated by the minimum of steam with consequent saving of fuel. The deepest mine in Colorado, the Geyser in Custer County, is 2,650 feet deep. It has 28 x 72 engines, double reels for 4,000 feet of flat wire rope, ⅝-in. x 7 in., capacity 30,000 lbs. at 100 lbs. boiler pressure, speed 2,200 feet per minute, weight 400,000 pounds. Each single reel of 2,865 feet of this rope weighs about 24,000 lbs.

In the matter of mine pumps equal progress has been made from the baling by bucket or primitive pumps of thirty years ago to the wonderful sinking and station pumps of to-day. The Argentum-

Juniata Mine, Aspen, has triple-expansion pumps, lifting 800 gals. per minute 1,000 feet, and the Ibex Mine, Leadville, Portland Mine, Cripple Creek, and a number of others have similar powerful pumps.

The Leadville Pumping Association, consisting of the owners of a number of adjoining extensive mines which had been temporarily closed, was organized for the purpose of unwatering the district covered by such properties, comprising an aggregate of many miles of deep underground workings. Two shafts were equipped with two pumps each, of an aggregate capacity of over 3,000 gals. per minute. Pumping was commenced 20th October, 1898, and continued practically without intermission until June, 1899, before the mines were sufficiently cleared to admit of the resumption of mining operations.

With all the local improvement in mining and ore-treatment machinery and appliances, Denver has become a great mining machinery centre, shipping not merely to all the mining districts from Alaska to Panama, but increasingly to other continents. For instance, three silver-lead smelters of Denver manufacture were recently exported—one to the island of Celebes in the Dutch East Indies, another to Tasmania, and a third to England. Concentrating machines, machine drills, and other apparatus of the most modern character of Denver manufacture are in increasing demand throughout the mining districts of the United States and other countries. The reason is simple. For nearly forty years the manufacturer of mining and ore-treatment machinery in Denver has been in close touch with the practical miner and mill-man, and the present perfection of locally-invented, or locally-developed and locally-manufactured, machinery and appliances is the natural result of their joint practical experience and desire to meet requirements. Moreover, Colorado and the adjoining States contain practically almost every variety of ore and the local manufacturers have been called upon to co-operate in the solution of almost every kind of metallurgical problem. All the before mentioned evolution tends to reduce cost of production and increased margin of profit. On such lines, the element of chance is reduced to a minimum, and mining, so far from being a gambling venture, as has too often been the case with the inexperienced and incautious, becomes a business enterprise as legitimate as the cotton, or wool or iron-manufacturing industries. Where mining has been entered upon and conducted on a conservative and common-sense basis, free from the peculiar practices too often connected with promotion, flotation, and stock-exchange manipulation, it shows greater average profits and less average losses than investments in railroads or banks.

EDITORIAL COMMENT

The unification which is resulting from the friendly competition between Great Britain and the United States in matters mechanical is well illustrated in the international yacht races, or rather in the construction of the yachts themselves. At the times of former races much interest was expressed in scientific and engineering circles as to relative influences of different forms and principles of construction upon the speed of such craft, and the theoretical principles involved occasionally formed the subject of interested discussion. With each succeeding race, however, the lines of the competing boats have approached each other more and more nearly, until on the present occasion the interest in the races seems to be confined almost entirely to a comparison of seamanship, the two yachts appearing to be so similar in design and construction as to decide nothing except the fact that each designer has profited by experience to select the good points of his opponent and abandon those which he has found defective.

A similar unification is becoming more and more apparent in other branches of construction, and it appears almost certain that before long the distinction of nationality in tool and machine design will have passed into the limbo of the forgotten, and that the best points of the designers of both nations will be merged into work which must be superior to that which has preceded. The laws of evolution hold good for all products of industry, and the survival of the fittest must be expected as truly for a lathe or a locomotive as for a mollusk or a man.

* * *

In these days of many journals devoted to all branches of technical and professional work, it is impossible for any man to keep up with the record of progress by his own unaided efforts, and indeed most men have given up the effort. Some cling to a few favorite periodicals, others have abandoned all attempts, and very many, without any premeditated plan, simply take up what they can, and gather, hit or miss, what may casually come before them.

All this is very unsatisfactory, and for a number of years attempts have been made to gather, classify, and abstract the mass of current information contained in periodical literature of various kinds, and the degree of success has been such that there are now a number of index systems and publications in existence, all doing good work in their various fields and all bearing evidence of the power and value of co-operation.

* * *

About the earliest attempt to make a published index of engineering literature was that initiated in 1884 by Professor J. B. Johnson, of St. Louis, who started a monthly index in connection with the *Journal of Associated Engineering Societies*. This index, conducted under many difficulties, and in connection with arduous duties of professional and educational work, grew to be an important feature of the collective transactions of the several

technical societies which form the Association, and in 1891 a collected volume of the work produced up to that date was published and found ready and valued acceptance.

* * *

At the beginning of 1896 the index published by the *Journal of Associated Engineering Societies* was discontinued in favor of that prepared by THE ENGINEERING MAGAZINE, and in the same year a second volume appeared, bringing the work of Professor Johnson and his associates up to date, since which time the index appearing monthly in THE ENGINEERING MAGAZINE has occupied its special field alone.

* * *

During the past few years interest in indexing technical and scientific periodical literature has been still more actively aroused. At the beginning of 1898 a new publication entitled *Science Abstracts* was started in London, devoted entirely to the indexing of current articles of scientific interest and value. This index, which is under the able direction of Mr. James Swinburne, assisted by a corps of abstractors, is devoted entirely to the subjects of physics and electrical engineering, and makes no attempt to cover the entire field, but for thoroughness of work and fullness of its abstracts it is worthy of highest praise. Following this English work comes a new French publication, *Le Mois Scientifique et Industriel,* conceived on much the same lines as the *Science Abstracts,* but extending its scope over a much wider field, including nearly every branch of applied science.

Besides these special periodicals many of the leading technical journals on the Continent publish at intervals index-sheets, more or less complete, of important articles of the day, and among the more notable of these may be mentioned the lists appearing in the *Zeitschrift des Vereines deutscher Ingenieure* and in *Glaser's Annalen* in Germany, and in *Le Génie Civil* and *La Revue Technique* in France. Some of the professional societies are also doing good work in this direction, notably the Institution of Civil Engineers, and the Iron and Steel Institute in England, and the American Society of Civil Engineers in New York. It is also understood that the Royal Society is making plans for a general indexing of current literature in the domain of pure science, while at the present time the International Institute of Bibliography at Brussels and the Concilium Bibliographicum at Zurich are vigorously attacking the whole field of current literature.

All this activity speaks well for the progress of methodical research, and the reproach can no longer be made against periodical literature that it is too ephemeral to be of value and that any faint impression which a writer may make is soon to vanish. In no line of work is the strength of union more apparent than in the effect of these concentrated efforts at classification and indexing of the records of the useful work of the world, and by such records men of action everywhere may well be seconded in their efforts to know "what to do and how to do it" by learning "what has been done and who did it."

REVIEW OF THE BRITISH PRESS

The Consumption of Water in Cities.

THERE has been much talk at various times about the waste of water by the consumers in towns and cities, and comparative tables are given to show what the proper consumption per head should really be. The difficulty of making any general rule for places in which the conditions are altogether different is well set forth in a communication to a recent issue of the *Journal of Gas Lighting*, and incidentally some very interesting points are brought out.

The words "rate per head per day" have really very little meaning, and convey but an illusory idea, when comparing the statistics of one town with another, and unless the circumstances and conditions are fully ascertained very misleading conclusions may be drawn. One town may have a record of only 20 gallons per head per day for all purposes, but examination would reveal that there are no gardens to be watered, that only half of the houses have water-closets, and that there are few baths or hot-water fittings.

"Conclusions based on such erroneous, hap-hazard statements, and manipulated by councillors who have not been educated in water-supply, can never lead to correct or useful results. It is well to compare such places with a modern seaside resort, where three-fourths of the houses have gardens for which the hose is used freely, where every house has one, and probably two closets and a bath (sometimes two), and where the town councillors in their wisdom advise a three-gallon, instead of a two-gallon flush, without any knowledge of the requirements, or any idea as to what an enormous output of water this unnecessary extra gallon amounts to.

"In different towns the consumption of water per head often varies to the extent of three times the average. This can always be accounted for. It is measured by the wants of the people, the facilities afforded for using the water, and the different habits of the population. Comparisons cannot be made even with towns of similar size and number of inhabitants; inasmuch as the rules and regulations are entirely different."

When the introduction of waste meters shows a reduction in the output it is usually found that no systematic attempt had previously been made to stop the waste. In other places the taps are washered gratis, and a rigid inspection is maintained, and the waste is reduced to a point where little or no economy will be produced by the use of meters. The rate per head per day is by no means uniform for the same place.

"Take the town of Richmond, which has a supply of 27 gallons per head per day for nine months in the year, while during the summer months 42 gallons are absolutely necessary; this being a town having a number of gardens on which hose is used." Other places are cited in which the consumption ranges from 24 to 42 gallons, but in every case there is some good reason for the difference.

"The difference in the consumption of water per day per head of the population where efficient and inefficient regulations are carried out and enforced by law, ranges from 20 gallons in the former to 80 gallons and upwards in the latter case. Therefore it is of the first importance that adequate rules and regulations should be enforced, and proper measuring apparatus—such as the Venturi meter—fixed on all outlet mains at the source of supply."

While these points are doubtless well made, and while the impossibility of comparing various cities under manifestly different conditions must be admitted, yet the consumption per head per day may at least be taken as a rough guide. When 80 gallons per head per day is considered evidence of waste and neglect, what shall we say to a consumption of 160 gallons and more, as we find recorded of some American cities? Under such conditions of waste there can be no wonder that it is impossible to furnish a reasonably healthful supply, or that the task of installing an adequate filter plant should become one of ap-

palling magnitude. While it may not be possible to say that the normal daily consumption per head should be a definite quantity yet it may at least be placed between certain reasonable limits, and, while good health may demand that the actual consumption should not fall below 35 to 40 gallons, yet certainly it is wasteful extravagance to allow it to pass the 100 gallon mark.

Electrical Engineers in Switzerland.

THE foreign reunion of the Institution of Electrical Engineers, which has recently taken place in Switzerland, proved to be a success in many ways, and from a review in the pages of *Engineering* we make some notes upon the progress and features of the excursion.

Switzerland has come to be so generally recognised as the centre of power generation and electrical distribution of Europe, that the wisdom of making it the place of an excursion of investigation must be conceded. Most of the Swiss plants include hydraulic work in the form of dams, conduits, tunnels, etc., as well as installations of turbines of the most modern design, driving powerful generators from which the current is distributed to many varied industries. Nearly all the machinery used in Switzerland is made within her own borders and the generation, transmission, and utilisation of natural sources of power seem to form a large portion of the industry of the country.

Overhead wires are the rule in Switzerland, and doubtless one of the facts which has assisted in the development of electrical power distribution has been the facility with which conductors have been allowed. High tension mains are allowed to traverse the country in all directions, and stringent legislation has been enacted for their protection, but it appears to be only a question of time when the multiplication of wires and the introduction of still higher pressures will compel some other means of dealing with the question of transmission.

The high reputation of the Swiss machine works, and the extent to which their products are used in the form of turbines, engines, and electrical machinery in the power plants rendered visits to the establishments an important and valuable portion of the meetings, while the inspection of the tramways, mountain rack-railways, and other transport applications completed a survey of the most active portions of continental Europe, so far as electrical work is concerned.

Some of the points upon which comments were made were those which would naturally attract the attention of foreigners. The peculiar arrangement of working hours in Switzerland, by which no work is done between the hours of 12 and 2 o'clock, is a handicap upon commercial efficiency, while the fact that some of the largest hydraulic power stations have had to be equipped with auxiliary steam plant for reserve in time of scarcity of water appeared to show that the "white coal" was not always to be depended upon.

On the whole, however, the visit to Switzerland was both interesting and instructive, and the many industries there successfully operated by electrical means should prove a further incentive to the extension of similar plants in Great Britain.

Large Cargo Steamers.

THE transformations which have been wrought during the past few years in the Atlantic carrying trade are well set forth in the paper read before the Institute of Naval Architects by Mr. G. B. Hunter upon the subject of large cargo steamers.

The growth which has taken place in this respect is best shown by reference to a table presented in Mr. Hunter's paper in which it appears that in 1891 the largest cargo steamer of the year was the Chancellor, of 4,753 gross tons, from which time there has been practically a steady growth. In 1896 the Milwaukee, of 7,317 tons headed the list, and in 1898 the Ultonia, of 8,056 tons, while at the present time the Invernia, of 13,200 tons, is under construction.

Without discussing any particular steamship Mr. Hunter proceeded to outline his idea of the Atlantic cargo steamer as she will be built in the immediate future. Such a vessel, for carrying large cargoes across the Atlantic economically and safely on a moderate draught might be designed to carry not less than 12,000 tons deadweight, with cubic capacity for 20,000 tons of cargo at 40 cubic feet per ton, and

1,000 tons of fuel. This would require dimensions approximately as follows: Length between perpendiculars, 500 feet; breadth, 60 feet; moulded, 36 feet to main deck, 44 feet to shelter deck; draught of water, loaded, about 27 feet 6 inches.

Since the heavy cargoes are practically carried only one way, viz., from the United States, there should be provision for sufficient water ballast for the outward voyage assuming no cargo. This would require not less than 4,000 to 4,500 tons of water ballast for a 12,000 ton vessel, distributed in the double bottoms, and in deep and in 'tween deck tanks. Large peak tanks are considered objectionable, as promoting pitching, vibrations, and uneasy motions, while no small portion of the strains on the machinery is caused by the too common custom of providing insufficient ballast when without cargo.

The question of powering such a vessel is not at present a difficult one, and is governed mainly by commercial considerations. "Large steamers are more easy and economical to drive than small ones. When they run in a regular line in turn with smaller steamers it is desirable for them to be fast enough to make up on the voyage for the longer time they take in port to load and discharge than the smaller steamers."

Many of the lines running to the East carry cargo at only about 9 knots, but in the head winds of the Atlantic somewhat greater power is desirable, and 11 to 12 knots is more nearly the rule. Three-cylinder triple expansion engines, with single ended boilers working at 180 to 200 pounds, with forced or induced draft is about as economical and durable an equipment as can be employed, and with skillful handling there appears to be no good reason why forced draft boilers should be short-lived.

The principal weakness which has developed in steamships is in the matter of shafting, and it is recorded in Lloyd's List that 198 steamers were disabled in 1898 through broken shafts, and 53 similar accidents have been reported for the first three months of the present year. While a portion of these cases may be attributed to insufficient ballasting, yet this can account for only a portion of them, and there is a growing tendency to advocate the use of heavier shafting, Lloyd's having already increased their requirements for propeller shafts about 16 per cent. with a further increase under consideration. Mr. Hunter, however, goes much further than this and advocates, for large single-screw vessels for Atlantic service, an increase in strength of propeller shafts of 100 per cent. above the present rules.

The use of twin screws and the accompanying duplication of power machinery is recommended, not only because of the greater efficiency of such an arrangement, but because of the insurance thus obtained against loss from breakdowns. The original cost is doubtless greater, but the advantages are sufficient to compensate for this when the ship itself may be worth £300,000 and there are 10,000 to 12,000 tons of valuable cargo aboard.

There seems to be little doubt that during the next 10 years there will be many of these large cargo steamers built for trade in all parts of the world, the advantages of cost and operation in comparison with the capacity amply warranting their general adoption.

The Progress of Steam Navigation.

THE address of Sir William White, President of the mechanical science section of the British Association, consists of a review of the progress of steam navigation, and coming from one who has played such an important part in the progress which has been made in that branch of applied science, his remarks are filled with interest and meaning.

After calling attention to the variety of conditions which must be met in steamship design, it is shown that in all types there is one common requirement, the attainment of a specified speed, and that there has been at the same time a continuous demand for higher speed. This element of speed is always intimately related with the elements of load, power, and fuel supply, and the two last have to be determined in each case. The nature of these relations is determined by the character of the service to be performed by the vessel, and by the crucial question, Will it pay?

The manner in which the controlling

conditions of steamship construction have been met is best illustrated by a study of the progress which has been made in the past, and this Sir William White gives in some detail, from 1840 down to the present time. It is impossible here to give his historical resumé of the leading vessels constructed since that date, but the summary is well worth studying, especially as it shows the close interdependence which exists between the shipbuilder and the mechanical engineer in the work of engine and boiler design.

"Sixty years of continuous effort and strenuous competition on the great ocean ferry may be summarised in the following statement. Speed has been increased from 8½ to 22½ knots; the time on the voyage has been reduced to about 38 per cent. of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased ten-fold in displacement. The engine power has been made forty times as great. The ratio of horse power to the weight driven has been increased fourfold. The rate of coal consumption—measured per horse power per hour—is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8½ knots, about 550 tons of coal were then burnt; now, to drive 20,000 tons across at 22 knots, about 3,000 tons are burnt. With the low pressure of steam, and heavy, slow-moving paddle engines of 1840, each ton weight of machinery, boilers, etc., produced only about 2 horse power. With modern twin-screw engines and high steam pressure, each ton weight of propelling apparatus produces from 6 to 7 horse power. Had the old rate of coal consumption continued, instead of 3,000 tons of coal, 9,000 tons would have been required for a voyage at 22 knots. Had the engines been proportionately as heavy as those in use sixty years ago they would have weighed about 14,000 tons. In other words, machinery, boilers, and coals would have exceeded in weight the total weight of the Campania as she floats to-day. There could not be a more striking illustration than this of the close relation between improvements in marine engineering and the development of steam navigation at high speeds."

After considering the corresponding advance which has been made in cargo steamers, war ships, torpedo boats, destroyers, and other special types, Sir William White proceeds to examine the progress which appears since 1840 in detailed portions of vessels and propelling equipment. In the motive power the principal improvements have come from the generation of much higher pressures of steam than were formerly possible, and from the improvements in the engines involved in the application of such high pressures.

The old flue boilers, with their flat, stayed surfaces, long ago gave way to the cylindrical boiler, which with its corrugated furnaces, has made working pressures of 160 to 180 pounds practicable, and these pressures have in turn led to the use of multiple expansion engines, and the consequent economy in steam consumption which forms so large a portion of the advance in marine engineering. The higher pressures which are still demanded have been attained by the use of water-tube boilers, and in view of the agitation against such boilers which is being conducted in certain quarters it is interesting to note what Sir William White has to say on that important matter.

"The use of water-tube boilers in recent cruisers and battleships of the Royal Navy has resulted in saving one-third of the weight necessary with cylindrical boilers of the ordinary type to obtain the same power, with natural draught in the stokeholds. Differences of opinion prevail as to the policy of adopting particular types of water-tube boilers; but the weight of opinion is distinctly in favour of some type of water-tube boiler in association with the high steam pressures now in use."

In connection with the gain made by the use of high pressure steam the advantages of higher rotative speeds must also be considered, and in this connection the steam turbine appears to be the important motor of the present and immediate future. It is anticipated that the use of turbo-motors will enable the weights now required for the engines, shafting, and propellers of Atlantic liners to be reduced one-half, while at the same time most, if not all of the injurious and wasteful action of vibration due to unbalanced reciprocating parts will be prevented.

The Glasgow Tramway Engines.

THE discussion produced by the circumstances attending the award of the contract for the steam engines for the Glasgow tramways possesses more than a mere passing interest, not so much for the details of that particular instance as for the light which it throws upon the differences in practice and opinions concerning steam engineering in Great Britain and the United States. It was quite natural that the original award of the contract to an American firm should have called forth expressions of disapproval, even though that firm had already received contracts for a number of engines for similar service in England. The fact that the objections took the form of adverse criticism of the proposed design, however, instead of the mere expression of a desire to have the work done at home, renders the matter one of engineering interest instead of local feeling.

Much has been published in various journals upon this subject, and from the columns of the *Engineer,* from editorials and correspondence, an excellent view of general opinion may be gathered. The controversy has been settled for the time by the award of one-half the work to the American firm and the other half to a British establishment, so that the practical result may well be left to settle itself, but leaving all matters of feeling aside the engineering points of the discussion will bear examining.

In the first place it is to be noted that only a few leading dimensions were given in connection with the specifications, and these were not made obligatory, as it was desired by the committee to leave the manufacturers as free as practicable to follow their own designs. At the same time it must be remembered that the engineer by whom the specifications were drawn, Mr. H. F. Parshall, although a member of the Institution of Civil Engineers, and long a resident and practitioner in England, is an American by birth and training, and has gained his experience in tramway machinery in the midst of the development of the numerous great American systems. The fact that Mr. Parshall, with this experience and with his unquestioned ability, did not see fit to draw up a detailed design for the engines, and require each bidder to conform precisely to identical details of construction, must be taken to mean that he desired to relieve the bidders from that close bondage to the restrictions of the consulting engineer about which so much has been heard of late. It is generally admitted that the freedom in design and construction which is permitted in America has had much to do with the development of fit types of machines for various lines of work, and to permit each builder to do the work to his best advantage, and this innovation in connection with such an important contract as that of the Glasgow tramway engines should be welcomed on all sides.

The real difficulty in this especial case appears to be the fact that up to the present time no engines of such size for this kind of work had been constructed in England, and experience in this particular line was lacking. It has been said that much larger marine engines have been most successfully designed and built in England, which is doubtless true, and it is well-known that British marine practice forms the foundation not only for American designers in that line, but also for those of other countries, but marine practice is not stationary power-house practice, and it is sound engineering to take the best wherever it can be found.

Of course it does not at all follow that successful and satisfactory engines for tramway service cannot be designed on other lines than those which have been developed in America, but to introduce a modified or different type in connection with such an important undertaking as that at Glasgow could hardly be regarded as other than a rather risky experiment. As a correspondent to the *Engineer* pointed out, the real difficulty in England has been the repressive influence of municipal authority, which, doing nothing itself, would allow others to do nothing, and so hampered the work of development in which the most valuable experience would certainly have been gained.

The principal point of criticism of the American designs is the large diameter of the shaft, especially of the shaft bearings, and the great weight and cost of the shaft as specified by Mr. Parshall had much to do with the amount of the bids. It is not probable, however, that an excessive size would have been adopted in America had not previous experience with lighter shafts

been unsatisfactory, and while disproportion is undesirable it is well to err on the side of strength and stiffness. The whole tendency of American practice has been toward moderate rotative speeds and massive parts, and when one remembers that the general criticism of American machinery in the past has been of its apparent lightness, this change to greater weight and strength must be considered as a concession to British ideas.

The controversy has not been without value in bringing out ideas and opinions which must bear fruit in future cases, and the outcome of the Glasgow incident will be watched with much interest on both sides of the Atlantic.

By-Product Coke Ovens.

THE importance of preventing waste and recovering all possible by-products in industrial technology is leading to the extended introduction of by-product coke ovens of various kinds, and the success which has attended such installations renders detailed information interesting. A recent issue of the *Colliery Guardian* discusses the working installations of Semet-Solvay coke ovens which have been made in various parts of England and shows the decided advantages which have attended their operation.

Although there has been much prejudice in England against the recovery oven, yet it has taken an excellent hold there, there being 370 ovens n operation with a product of more than 400,000 tons of coke per year, England coming second only to Belgium in this respect. "The coals of each country differ very considerably, and this has been one of the difficulties in the introduction of the recovery oven into England. Continental coal seems to have been more adaptable to the new process than English coal. Could we fix the quality of the coke by the percentage of carbon in the original coal, there can be no doubt that long before this, the recovery oven would have made far greater progress in England than it has done."

There have been no figures made public by which the comparative performance of beehive and recovery ovens in England can be obtained, but from trials made in the United States it appears that although the cost of the by-product oven is about five times that of a beehive oven, yet the total output of the former is so much greater that the cost per ton of coke produced is only about three-fourths as much for the recovery oven as for the older type. The value of products of the by-product oven is given as $14.68 per day, as against 93 cts. for the beehive, this not including the gas, which was not taken into account in either case.

There appears to be no reason why as high economies may not be obtained in England and figures given for English coals show that the market value of the by-products from a given quantity of coal is decidedly greater than that of the coke.

The products generally recovered by Semet-Solvay ovens are tar, ammonia, and benzine. The tar is either sold as made or subjected to a fractional distillation, the ammonia is converted into sulphate of ammonia, for which there is a regular market, and the benzine is treated and rectified into naphtha and benzol and finds many applications. In addition to these products, however, the gas from the coke ovens is now found to be a most valuable product.

The first portion of the gaseous distillate is rich in illuminants and may be collected in a special holder for use in illuminating purposes, while the remaining portion is almost equally valuable as a fuel gas, being either burned under boilers or preferably used directly in gas engines, for which latter purpose its high calorific power renders it eminently adapted.

In view of the large portion of value in the coal which goes to waste when recovery ovens are not used it certainly appears that every effort should be made to overcome any objections which may exist as to their adaptability to all cases. A study of the influence of the method of coking upon the character of the product should render it possible so to modify the operation as to permit the valuable by-products to be utilised in all cases, and yet retain the highest value in the coke as well.

Review of the Continental Press

Mechanical Traction for Canals.

With the general interest which exists in the development of internal waterways in central Europe there has also arisen an activity in devising substitutes for animal traction. The entire subject of mechanical traction in connection with internal navigation is treated exhaustively in a paper by M. Galliot in the *Revue de Mécanique*, while the application of electric traction to canals is discussed at length in a paper in the *Elektrotechnische Zeitschrift* by Herr G. Klingenberg.

As a matter of fact, the present system of animal traction is most primitive, there having been little or no improvement since the most remote times, and although nearly a century has elapsed since the application of steam power to navigation, we still see boats hauled along the canals by horses, mules, and even by men.

It is largely on this account that canal navigation has been regarded by some as a system of transport which is gradually becoming obsolete, and which is destined to be superseded entirely by railways; but when we consider that in many cases the canals have been acquired by the railways in order to divert the traffic, and consider the utter neglect which has until recently been shown toward the older method of transport, we see how mistaken an opinion may be when it is based upon such peculiar conditions.

Apart from any system which merely involves the use of steam tow-boats, the methods which have been seriously applied to canal service may be divided into three classes; (1) screw propellers, fitted to the boats themselves, (2) chain or cable towage, operating by power-driven drums on the boats, and (3) electrical towing machines running on the tow-path or on a track by the canal, and hauling the boat by tow line.

The use of screw propulsion is one which naturally suggests itself when the question is brought to the notice of the general observer, but the peculiar conditions attending canal transport have rendered it difficult to make a satisfactory solution of the problem in this manner. In the first place it is very desirable that no important change be made in the construction of the thousands of existing canal boats, and so it is hardly practicable to install an entire engine, boiler, and screw equipment upon each boat, especially since this would detract materially from the carrying capacity. This difficulty has been met by placing a motor in a sort of a box rudder and connecting it directly with a propeller projecting from the rudder. The high speed of the electric motor enables a small propeller to be used, and the electric current can either be taken from a feed wire running along the bank, or be produced by a small engine and generator standing on the deck of the boat.

While the idea of placing the power in the rudder, first suggested by M. Trouvé, avoids the cutting of the boat and renders the old boats available, yet it possesses the disadvantage of so lengthening the boat as to interfere with the passage through locks, and in many cases the time lost by unshipping and re-shipping the rudder is sufficient to condemn the apparatus. The clumsy shape of the stern of the boats as now made also renders it difficult to attain speed, owing to the wake which causes the propeller to draw air and lose in power and efficiency.

The use of fixed cables or chains in connection with power-driven drums on the boats, is an very old idea, and has been used with some success, especially on the Rhine, where heavy chain-towage is still in regular operation; but this system is hardly applicable to the great bulk of canal transport, and must always be limited to motor boats hauling heavy trains of canal barges behind them. Few if any installations of this kind are now being made, and they are very unlikely to come into future extended use.

In all probability the third method, that of haulage by some form of travelling ma-

chine running along the bank, offers the best prospect of success, both from a mechanical and a commercial point of view. This method includes not only hauling machines acting by direct towage, but also running cables to which the boats may be connected and disconnected. Running cables have been a subject of experiment since 1869, when a patent was taken out by MM. Troll and Mercier, and since then numerous modifications have been made, principally in connection with the supports and grips, but in spite of the perfection to which these details have been brought, this form of canal towage has not been found acceptable.

Towing machines running along the path have been quite successfully mechanically, and several forms of these are now in use. The first of this kind dates back to 1839 and was devised by M. Larmanjat. In this case a steam traction engine was used, there being a single rail to act as a guide while the weight of the machine was carried by large wheels running on the tow path, but the cost of operation at that early date prevented the system from coming into use.

The same idea, using electricity, has now been revived in France by M. Galliot himself, and in Germany by Siemens & Halske, the principal difference between the two systems being that the first uses a machine which runs on the ordinary tow path, while the latter requires a narrow-gauge railway by the side of the canal. Both of these systems are now in actual use, that of M. Galliot being introduced by MM. Denèfle & Cie on the canals of the Aire and the Deule, in France, and that of Siemens & Halske on the Finow Kanal in Prussia. In the first case there is a separate machine for each boat, the whole apparatus weighing about two tons, and being capable of exerting a uniform tractive power of 1,000 pounds, or an emergency pull of a ton. The machine is controlled by an operator who rides upon it and steers it as well. The principal objection which was urged against a machine running upon the tow path was the possible damage to the road way, but with the wide rimmed wheels and a properly made road, it is found that there is less injury to the path by the machines than from the horses. Since the power is taken by a trolley pole from an overhead wire there is no interference whatever with the path for animal traction, and the system can be gradually introduced in connection with the older plant, and no change whatever is needed in the boats.

The Siemens & Halske system is intended for hauling trains of barges, and is intended to supplant horse traction entirely, and while it will doubtless be an entire mechanical success it is much more costly in installation.

The crucial question of commercial economy has yet to be settled, and cannot be decided until after a prolonged trial under actual operative conditions, but there is every reason to believe that if success is attained it will be along the lines of the last two systems.

The Ventilation of Tunnels.

THE development of railway construction has caused the construction of tunnels and subways to become a most important department of the work of the engineer, and the increasing use which is made of such passages by railway trains has drawn attention more and more to the necessity of providing sufficient ventilation.

When a tunnel is of but moderate length and is traversed by but few trains the natural ventilation due to a difference in pressure of the atmosphere at the two extremities or to a difference in temperature between the interior and exterior, is sufficient to change the air frequently enough to prevent serious annoyance. When, however, there is not a sufficient natural ventilation it is necessary to provide some artificial method of changing the air, and in practice this has been found to be by no means an easy task.

The question of the ventilation of tunnels forms the subject of a series of articles by M. Raymond Godfernaux, published recently in *Le Génie Civil*, these forming a complete monograph treating of the conditions found to exist in practice, together with the theoretical considerations which govern the possible remedies, and in view of the fact that imperfect ventilation has come to be a source of danger as well as discomfort, any discussion which will aid in the solution of the problem is welcome.

The principal sources of definite infor-

mation, and those upon which the discussion of M. Godfernaux is based, are the reports of the committee on ventilation of tunnels of the Metropolitan Railway of London, and of the commission appointed by the Italian Minister of Public Works to investigate the tunnels of the railways of the department of the Adriatic.

Although the vitiation of the air in a tunnel may proceed from three sources, *i. e.*, the lighting, the respiration of the passengers, and the combustion of the fuel in the engines, yet the two former sources are insignificant compared with the latter, which alone need be considered. The principal products of combustion which are injurious are carbonic acid, carbonic oxide, and sulphurous acid. Of these it is found that the proportion of carbonic oxide should not exceed 0.01 per cent., which corresponds to 0.13 per cent. of carbonic acid in excess of the normal proportion of 0.03 per cent. and to 0.00027 per cent. of sulphurous acid. In practice it is found that if the total proportion of carbonic acid be limited to 0.15 per cent. the proportions of the other gases will be well within the comfort and danger limits. This is much lower than is often attained in crowded auditoriums, where the proportion of carbonic acid sometimes reaches 0.4 to 0.5 per cent., but in such cases there is no carbonic oxide produced, while in the case of tunnels traversed by steam locomotives we may assume that the carbonic oxide will be about 1-13 of the carbonic acid, and the sulphurous acid about 1-440.

Assuming a given limit of deterioration of the air it would be easy to devise a system of ventilation if it were possible to treat the tunnel as if it were a closed room or controllable space. In practice, however, the conditions are peculiar. The space to be ventilated is a long narrow passage, usually open only at the ends, and traversed periodically, often almost continuously, by trains in one or both directions, these trains emitting the objectionable gases and also disturbing the air currents best adapted to proper ventilation. How best to reconcile these conflicting conditions forms the problem under consideration.

Where there are but few trains it has been proposed to close the ends of the tunnel by doors and provide a fan exhaust or pressure system, but this method is obviously limited in its applications. The practical conditions which must be considered are those in which frequent trains in opposite directions pass through the tunnel, and these conditions M. Godfernaux has analysed graphically in a very interesting manner. Assuming a double track tunnel 800 metres in length with an exhausting ventilator placed in the middle, and with trains of a given gas producing capacity passing on each track every three minutes, he constructs a diagram showing how the composition of the atmosphere of the tunnel varies at successive points, and how by an examination of the diagram thus made it is possible to discover the maximum vitiation of the air, and consequently the extent to which the conditions are satisfied. By one or two such constructions any such problem may be solved to a degree quite within the limits of practical work, and the effect of various systems of ventilation compared.

M. Godfernaux discusses various systems of ventilation, including those involving the use of shafts, fan blowers and exhausters, and air jets, and concludes with a description of the Saccardo system, already described in these columns, as applied to the Appennine tunnel of the Bologna-Pistoia line, and to the St. Gotthard tunnel.

While all this investigation and discussion is of much value, it certainly seems as if the true remedy lies not so much in the removal of deleterious gases as in the absence of their production. The substitution of electric traction avoids altogether the fouling of the air of tunnels and subways, and electric locomotives are already used in the Baltimore tunnel in the United States and elsewhere, and it seems as if this remedy is the true one to be applied in all cases.

Alcohol Incandescent Lamps.

THE success which has attended the introduction of the Auer incandescent mantle in connection with lighting by gas has led to various attempts to utilise the same principle with other heating media, especially with petroleum, alcohol, and various combined fluids. This matter formed the subject of a paper before the *Société des*

Ingénieurs Civils de France by M. Denayrouze, who has himself contributed extensively to the improvements which have been made in lighting by incandescence, both in connection with gas and with liquid hydrocarbons.

It is well understood that the illuminating power of gas is entirely due to the incandescence of particles of carbon, and the wastefulness of this mode of lighting may be realised when it is understood, according to Saint-Claire Deville, that the hydrocarbons which form the illuminating portion of ordinary gas constitute but from 3 to 6 per cent. of the total volume, while the remaining portion is capable by its combustion of raising a much large mass to incandescence than is provided by the hydrocarbons present. It is its great richness in readily decomposed hydrocarbons which renders acetylene of such high illuminating power, while the introduction of an incandescent mantle composed of rare earths, as in the Auer burner, shows how great an advance may be made with ordinary gas.

It was a natural step to attempt to place such mantles over burners fed with liquid fuel, and in Germany various designs have been made, using methylated spirit, and even petroleum. Difficulties of various kinds were encountered, however, the principal one being an insufficient admixture of air to produce the high temperature necessary, and most of the devices are still in the experimental stage.

M. Denayrouze exhibited before the Société, however, a lamp containing the results of his latest researches which seems to show that the difficulties have been surmounted in a practical manner.

An ordinary Welsbach mantle can be heated to incandescence over an alcohol burner and thus be made to emit a brilliant light, but the cost is higher than desirable and the illuminating power limited. M. Denayrouze has taken this idea and supplemented it by charging the alcohol with hydrocarbons in solution to such an extent that the carbon in the flame and deposited upon the mantle also becomes incandescent, and adds greatly to the light without causing any increased consumption of alcohol.

While M. Denayrouze exhibited his lamps freely before the society, he did not give any very precise details as to the nature and quantity of the dissolved hydrocarbons which he used to reinforce the illuminating power of the mantle. The idea, however, is readily intelligible and there should be little trouble in reproducing his results, now that the matter has been made public. The effect of the carburetted alcohol is clearly shown by the fact that when burned in specially designed lamps a very brilliant light is produced without the use of any mantle whatever, so that the combination of the two sources of light, especially when assisted by a slight blast of air, gives remarkable results.

The field of investigation which has thus been opened should lead to an active study and to the development of sources of illumination hitherto little used, and while electric lighting and incandescent gas-lighting will probably hold the larger portion of the field between them for a long while to come, yet for portable lighting, such as railway carriages, and similar service, some system such as offered by M. Denayrouze may be found decidedly preferable.

Internal Combustion Motors.

THE high economy which has been demonstrated to be possible in the case of the Diesel motor has attracted much attention to internal combustion motors of all sorts during the past year, and there appears to be little doubt that much better results can be attained from various forms of such machines than had hitherto been thought practicable.

Among those who have devoted attention to this subject is the chief engineer of the well-known firm of Ganz & Co., of Budapest, Professor Donat Banki, and a very complete discussion by him of the principles involved in the economic performance of internal combustion motors is given in a recent issue of *Le Génie Civil,* being a translation of the original paper in the Hungarian review *A Magyar Mörnèk.*

Assuming that the phenomena in the cylinder of a motor of the internal combustion type may be considered simply as those belonging to the variations in pressure and volume of a given mass of air under varying conditions of temperature, Professor

Banki proceeds to investigate the influence of various modes of introduction of heat in the cycle. This he does, as others have also done, by the study of various curves, constructing what are practically indicator diagrams for the different conditions assumed. By comparison of these curves he then seeks to determine which one, for a given compression may be expected to give the highest degree of efficiency.

By a similar analysis Herr Diesel concluded that the greatest economy would be secured by isothermic combustion, the loss of heat by conversion into work exactly corresponding to the generation of heat by combustion, the temperature during expansion therefore remaining constant, and these conditions he sought to realise in his motor. This method involves a continuous combustion, and not a very rapid, or almost instantaneous explosion, and Diesel has designed his motor so as to feed the combustible gradually into the cylinder, where it is slowly and completely burned.

Professor Banki, however, deduces that the highest economy is attained when the terminal temperature is the lowest, assuming in each case the same quantity of heat, and demonstrates mathematically that this is secured by a motor of the explosion type, the combustion being practically instantaneous.

This conclusion is based upon the same degree of compression in each case, and a further examination is then made into the influence of compression upon economy. Here some interesting deductions appear. The compression may be either isothermic or adiabatic, and Professor Banki shows that the latter should theoretically give the best result. The degree of compression, however, has an important influence. For moderate pressures it appears that the indicated and mechanical efficiency is greater for explosion motors than for combustion motors, while for high degrees of compression the two varieties approach more nearly in efficiency, and for very high compressions the advantage is on the side of the combustion motor.

In the case of high compressions it is necessary to compress the air separately from the fuel, in order to avoid premature ignition, and this is the practical method adopted in the Diesel motor.

The conclusions of Professor Banki might readily be checked by experiment, and in fact such tests as have been made with motors of the types discussed confirm his deductions. For motors operating with slow combustion the compression should be as nearly adiabatic as possible, and there should therefore be as little cooling of the cylinder as possible, only sufficient to prevent injury to the cylinder and piston being employed.

If the combustion can be controlled, the best result should be expected by providing an isobaric combustion, the pressure neither rising nor falling until the fuel is consumed, and this with adiabatic compression will give a high degree of economy if the compression is sufficiently high. If the compression reaches 30 atmospheres the thermal efficiency may reach 40 per cent., a degree not yet attained in actual practice.

Professor Banki is most ready to give Herr Diesel full credit for the work he has done in indicating and applying the correct theoretical principles to internal combustion motors, and considers his work to be as important in petroleum motors as was the introduction of the four-cycle compression gas-engine by Otto in its line.

Professor Banki has himself devised a motor in which high compression may be employed in connection with the simultaneous admission of the combustible without danger of premature ignition, by using a sprayed injection of water into the working cylinder. The presence of the moisture delays the ignition to any desired point, while after, or rather during, the combustion the spray is converted into steam, the motor practically becoming a steam engine using superheated steam generated in the cylinder itself. Several engines of this design have been constructed and show an efficiency equal to that of the Diesel motor, a consumption of only 208 grammes of petroleum per horse-power-hour being required, with a mean effective pressure of 10 atmospheres.

Under these circumstances it appears as if it were only a question of a very brief time before petroleum motors designed upon the principles demonstrated by Diesel, Banki, and others will come into general use, not only for small powers but also for general service.

Incandescent Electric Lamps.

An important question in connection with the operation of electric lighting plants is that of the value and efficiency of various forms of incandescent lamps, and a valuable discussion of the relation between power consumed and illumination furnished forms the subject of a paper by Inspector Loch, in a recent issue of *Glaser's Annalen*.

The ordinary life of an incandescent lamp is placed at 800 to 1,000 hours, but this extreme duration of the filament is by no means the measure of its illuminating usefulness. The real point at issue is the maintenance of uniform illuminating power. In some instances lamps reach a life of 1,000 hours only with a great diminution in brilliancy, while in others a useful life of 3,000 to 4,000 hours has been attained.

As a rule those lamps which yield a brilliant light at first for a given consumption of electrical energy, show also a more rapid falling off in brightness than those which start with a weaker light.

With the falling off in illuminating power there appears also an increase in the consumption of electrical energy. An average consumption for a new lamp is from 2 to 4 watts per Hefner candle, while this may increase to 9 watts per candle before the lamp fails.

There is, however, a great difference in different lamps, even of the same makers. Lamps rated at 16 candles are found to vary between 10 and 30 candles, while 25 candle lamps may range from 15 to 50 candles. A moderate increase in pressure makes a marked increase in brilliancy, and hence Siemens & Halske stipulate for a variation in pressure of not more than 2 per cent. either way from the normal rating of their lamps, *i. e.*, for a 16 candle lamp at 110 volts the pressure should not exceed 112 volts nor fall below 108 volts.

In order to investigate the subject fully, Herr Loch conducted a series of experiments upon a number of incandescent lamps, noting both the life and duration of brilliancy as well as the consumption of electrical energy, the results being plotted in the form of curves. The lamps for the tests were furnished by the makers in accordance with certain specifications, with the intention of securing, as nearly as possible, articles of normal character. Each lamp was required to be tested, and it stipulated that during the first twenty-four hours the illuminating power should not vary more than 6 per cent. either way from the normal, while each lamp was also obliged to stand a run at pressures 2 per cent. above and below the normal rating without showing injury. The normal consumption of energy was required to fall between the limits of 2, 5, and 3.5 watts per candle, and the illuminating power must not fall more than 15 per cent. during the first 480 hours. At the end of this period it was also required that the consumption of electrical energy should not have increased more than 20 per cent. over that required at the beginning.

The records of the tests are given very fully in the article referred to, both graphically and in tabular form, and to the original publication the reader must be referred. The general conclusions, however, were altogether clear, and can readily be summed up.

The tests, as indicated above, were made for twenty-four hours, in order to enable the preliminary measurements to be made, after which the 480-hour trial followed, and such lamps as survived were then continued on trial until a total of 960 hours had been completed.

The general result of the investigation showed that the consumption of electrical energy continued about the same per lamp throughout the entire test, having fallen off but slightly at the termination of 960 hours, but the illuminating power diminished steadily during the same time, so that the power per candle increased materially; in one case the energy per candle increasing from 2.45 watts to 6.75 watts, the candle power having fallen from 24 to 8 during the run of 960 hours.

These evidences of deterioration in incandescent electric lamps correspond to a great extent to those which have been noted in connection with incandescent mantles for gas lamps. A similar falling-off in illuminating power is observed, while the consumption of gas remains the same and hence the efficiency is reduced. It is evidently in the interests of economy to observe the performance of both kinds of lamps and replace them before the waste becomes excessive.

REVIEW OF THE AMERICAN PRESS

The Water Supply of a Great City.

THE tendency of the times to the concentration of population in great centres has brought with it many problems connected with sanitation which demand the best skill of the engineer for their solution, and among these problems one of the most important is that of water supply. The latest contribution to this subject is found in the report of the board of experts appointed to recommend the best means for the extension and improvement of the water supply of the city of Philadelphia, and in view of the high standing of the experts, Messrs. Hering, Wilson and Gray, and of the magnitude of the undertaking, the report has been awaited with interest by that large branch of the engineering profession engaged in municipal work.

For a long time the water supply of Philadelphia has been a subject of very just complaint. In the words of the report: "The water supplied to some parts of the city is scarce in quantity, and in all parts inferior in quality." The supply is drawn from the Schuylkill and Delaware rivers, which although originally pure, have long since become greatly contaminated by drainage and other pollution, so that last summer an epidemic of typhoid fever was produced.

As a natural consequences of these complaints various propositions have been made from time to time looking to the improvement of the water supply, and, as usual in such cases, a number of "schemes" have appeared looking to private profit rather than to public welfare, the political element in these "water snakes" being especially prominent. Most of these schemes involved the bringing of supposedly pure water from a distance, and a number of such sources of supply have been proposed, but on the other hand it has been maintained that the true sources for the city's water supply were the rivers already at hand, it being held perfectly feasible to purify the water so as to render it palatable and wholesome.

The great difficulty attending the introduction of any satisfactory purification process in Philadelphia has been the excessive waste which has been permitted, the water department being obliged to supply nearly 200 gallons per head per day for every man, woman and child of the 1,300,000 population. The present very able Chief of the Water Bureau has called attention year after year in his reports to the fact that this waste must be stopped before any system of purification could be applied, and he has persistently and consistently advocated the introduction of water meters and the construction of filtration plants.

Notwithstanding the fact that a complete and satisfactory solution of the problem had thus been presented, the municipal authorities decided to call in a commission of experts to report upon the "immediate improvement and extension of the water supply," and this commission has been brooding over the subject for more than three months, the result being the report which is now made public.

In many respects this report is very interesting reading, and although much of it relates directly to the conditions belonging to the local situation, yet it contains so much important matter which applies to other large cities that an abstract of its contents is of more than local interest.

After a brief description of the present plant the report takes up the question of waste and shows that it has grown up almost entirely since the introduction of modern sanitary appliances, which in themselves are not wasteful of water, but which readily become so by neglect. In 1885 the consumption was about 75 gallons per head per day, and the condition of the health of the city at that time, as well as the experience gained from other cities, shows that this amount is ample for all reasonable purposes. The commission, however, for some reason known to itself, recommends that the basis of future supply be made double this, or 150 gallons, and then proceeds to advocate the introduction of meters to limit the consumption to this amount.

On the question of meters the report is outspoken and fearless, and it is a matter for congratulation that this important measure has received such an unqualified indorsement. The report says:

"We earnestly recommend the introduction of meters for the city of Philadelphia with perfect confidence that the private consumer is given full and ample use and enjoyment of all water for his needs and comforts, at no greater cost, and probably, in many cases even less cost than the present rates impose."

Assuming then that the supply be reduced to limits which the most rabid advocates of liberality must admit are more than ample, the commission goes on to recommend sand-filtration as entirely capable of rendering the water of the Schuylkill and Delaware rivers pure and wholesome.

Many people have an idea that filtration is nothing more than a sort of straining, rendering the water clearer than before, but not removing the sources of disease which may be contained in the form of pathogenic bacteria. The report shows, as indeed is well known to those who have studied the subject intelligently, that from 98 to 99 per cent. of the bacteria are removed entirely by filtration and that "a filtered water supply, under skilful management, offers a greater security against the effects of accidental pollution of the water than is possible when the supply is taken from open, unprotected water courses. Filtration can without difficulty be made to render the water thoroughly wholesome."

Here, then, are enunciated the two fundamental principles of water supply for any great city situated by a river. First, the use of meters, to prevent the waste from becoming so great as to render filtration impracticable; and, secondly, the use of slow sand filtration, a process covered by no patents, but open to all, as a means of providing, even from polluted sources, a supply entirely wholesome and satisfactory.

It is especially interesting to note that these conclusions are identical with those which the present Chief of the Philadelphia Bureau of Water, Mr. John C. Trautwine, Jr., has been urging upon the city authorities for a number of years, and in fact the report of the commission reads as if it had been compiled entirely from Mr. Trautwine's annual reports to the Director of the Department of Public Works. The city might well have been spared the delay and expense of this special commission, simply by following the recommendations of its own expert engineer, but having acted otherwise, it is at least assured that these important recommendations will be well carried out by the man with whom they actually originated.

Mechanical Stokers on Shipboard.

IT is generally admitted that the stoking of marine boilers ranks among the most laborious and exhausting occupations, and in view of this fact as well as of the important influence which careful stoking has upon the economic performance of the boilers, it is somewhat surprising that greater efforts have not been made to apply mechanical stokers to marine boilers.

An important contribution to this branch of work now appears in the *Journal* of the American Society of Naval Engineers in the form of an account of the test of the machinery of the lake steamship Pennsylvania, by Lieutenants B. C. Bryan and W. W. White, U. S. N., this test including not only the stokers, but also the main engines, auxiliary machinery, and water-tube boilers. Although the vessel is the property of a private company, the test was made under the auspices of the Bureau of Steam Engineering of the United States Navy Department, and thus the results may be considered as official.

The Pennsylvania is a large steamer, being 450 feet in length over all, with a displacement of 10,155 tons, and is fitted with a quadruple expansion engine of 1,600 h.p., two Babcock & Wilcox water-tube boilers, intended for a pressure of 250 pounds, with three mechanical underfeed stokers to each boiler, and an entire equipment of independent steam auxiliaries, none of the auxiliary machinery being operated by the main engines.

Although full data of the tests of all this machinery are given in the paper, it is distinctly stated that they were primarily made for the purpose of observing the practical adaptability of underfed stokers, as manufactured and installed by the American Stoker Company, to boilers of sea-going vessels, especially with a view of deter-

mining the economic results where an inferior grade of slack coal is used. The coal used on the Pennsylvania contained a large proportion of refuse, and a sample tested in a Mahler bomb calorimeter gave a calorific value of only 11,790 B. T. U. per pound.

The stoker consists essentially of a central magazine, a coal hopper, a screw conveyor or worm, a wind box, cast-iron tuyeres or air blocks, and an independent steam motor for driving the conveyor shaft. The coal which is thrown into the hopper is fed into the central magazine of the stoker and forced upward, gradually overflowing the tuyere blocks. The volatile gases are gradually released by a sort of coking, and burned in connection with air issuing through the tuyere blocks, and the coked fuel finally burned on the dead grates at the sides.

Five full tests of six hours' duration were made of the main engine, including, of course, the boilers and stokers. During these tests all the water fed to the boilers was weighed in tanks, the coal also being carefully weighed on platform scales. The steam used by the auxiliaries was determined by condensing the exhaust and weighing the water, while the quality of the steam made by the boilers was determined by the Barrus calorimeter. Indicator cards were taken at frequent intervals, and the flue gases from the furnaces were tested by the Orsat apparatus.

In the original report full tabulated records of the data and results of the tests will be found, and there is only space here for a statement of the general results.

The only numerical statement which can be obtained of the performance of the stokers is that of the evaporative performance of the boilers, and when it is seen that the evaporation was 8.8 pounds of water per pound of slack, or 10.9 pounds per pound of combustible, with practically dry steam, it will be seen that the firing must at least have been as good as hand firing. According to the text of the report it is stated that: "The steam was generated at all times without difficulty, and no doubt with greater ease and economy than if hand firing had been employed. Only an extremely light smoke was observable during the ordinary working of the stokers. Practically it may be said the coal was burned smokelessly, except when the cleaning doors were opened, either for slicing or clinkering. At such intervals considerable smoke issued from the stack."

These trials then appear to have demonstrated that under the conditions existing upon freight steamers on the great lakes, mechanical stoking is both feasible and economical. It must be remembered that these trials were made with water-tube boilers, but there appears to be no good reason why such stokers cannot be used to advantage with cylindrical boilers, although there is every probability that the water-tube boiler will soon become the rule for marine service. The substitution of machinery for human labor in this exhausting work is certainly greatly to be desired, both for mechanical and sociological reasons.

The tests of the machinery showed, among other things, two interesting facts, one being that the quadruple expansion engine gave little or no gain in economy over triple expansion engines as now designed for pressures approaching 250 pounds, and the other, the fact that when the exhaust steam is used for heating the feed water, steam auxiliaries may be operated at a cost of only about 10.5 per cent. of the total steam generated by the boilers. "The cost, therefore, of operating independent auxiliaries in connection with an exhaust feed-water heater, as compared with attaching them to the main engine, when the above percentage is not exceeded, is only trifling, and more than offset by the many obvious advantages of independent machines."

Reaction Breakwaters.

THE use of parallel jetties for the purpose of concentrating the scouring action of streams is well known, and when applied with judgment this method of deepening channels has proved eminently successful, a notable example being the work of the late Captain James B. Eads at the mouth of the Mississippi river. In many cases, however, it is desired to deepen the channel over a bar where there is no river discharge to be concentrated, and in such cases the contraction of the harbor entrance by means of jetties has not always proved successful.

A number of years ago Professor Lewis M. Haupt, of Philadelphia, brought forward a method of improving tidal harbors by means of the so-called reaction breakwater. This idea consisted in the application of a curved breakwater, so arranged that the potential energy of the ebb current was concentrated on the crest of the bar, producing the scour needed to deepen the channel.

Although Professor Haupt's idea did not at first meet with approval by Government engineers, yet, after other plans had entirely failed, his system was allowed to be tried at Aransas Pass, Texas, and the nature and result of the experiment is discussed in a paper presented before the American Society of Civil Engineers, and published in the *Proceedings* of the society.

The difficulty of the situation at Aransas Pass renders the problem one of especial interest. There is no stream to be directed or utilized, and the tide is but slight, being only 14 inches, so that the available energy is not great. Attempts were made by the government to build a jetty and to produce a 12 foot channel, but after the expenditure of more than half a million dollars this attempt was abandoned.

In 1895, a private company undertook the construction of a reaction breakwater after Professor Haupt's method. This breakwater is of an S shape, being detached from the shore in order to permit the tidal compartments of the inner bays to be filled freely by each flood tide. The breakwater is composed of curves whose radii and centres are adjusted to the site in such a manner as to cause deposits on the outer side of the structure, thus re-enforcing it, and scour on the inner side where an excess of foundation material revets the slope, the scour being assisted by gravity and the advance of the bar seaward thus prevented.

In the construction of this work a portion of the old jetty was encountered, and the intersection of the two works formed a sort of pocket which caused an accumulation of sand and prevented scour. A partial breach in the old jetty was made although it was not entirely removed, neither was the reaction breakwater entirely completed. The work was left in this condition early in 1897, and at that time a depth of but 8.5 feet was reported. The Government engineers evidently considered the breakwater a failure, and so reported, but now it appears that during a period of 15 months the artificial scour produced by the breakwater has increased the depth to more than 22 feet. This remarkable result tends to confirm the theoretical views of Professor Haupt, and to show that the force of even a moderate tide, when properly directed, may be utilized to produce a navigable channel, unaided by the flow of a stream or by dredging.

This simple structure marks a distinct advance in the resources of maritime engineers in the improvement of ocean bars, and its success in this instance should lead to its extensive adoption. Those who realize the efforts which Professor Haupt has made to convince the engineering world of the soundness of his views in this matter cannot fail to be gratified at the success which has attended this practical demonstration of the correctness of the principles which he has advocated.

Concrete-Steel Bridge Construction.

THE readers of these columns must have observed the frequency with which articles upon the subject of reinforced concrete have been reviewed, and it is believed that this fact is but an indication of the general interest which is taken in the subject. Most of the published accounts of structures of this character have appeared in continental publications, but of late a number of combined steel and concrete bridges have been built in the United States, and now we have in a recent issue of *Engineering News* a very full discussion of the whole subject, by Mr. Edwin Thacher, who is well qualified by experience to speak with authority.

As defined by Mr. Thacher: "A concrete-steel structure is a combination of concrete and steel in which steel in any form is rigidly embedded in concrete, the concrete stiffening the steel, and the steel reinforcing the concrete."

Such combinations are possible for the reason that concrete and steel have practically the same coefficient of expansion, so that the two elements of the structure act together in resisting the stresses.

Originally the idea of reinforcing concrete structures by iron or steel was suggested by the greater resistance of concrete to compression than to tension, and

Monier, in whose efforts the present extended interest in the matter originated, began simply by imbedding wire nettings in concrete arches, placing the metal near the surface of the intrados and extrados, in order to meet the tension stresses which might be developed in those portions of the structure. The results were so remarkable that general attention was directed to this form of construction, and as the use of nettings was attended with structural inconveniences, Professor Melan suggested the construction of a light framework of steel beams, forming a sort of skeleton structure, the beams being either solid or lattice according to the dimensions, and the whole being buried in a monolithic mass of concrete.

Experience having shown the high resisting power of steel wires to forces tending to withdraw them, when imbedded in concrete, some very simple forms of reinforced concrete construction have been used for short spans, especially in connection with floors and other interior work in fire-resisting building construction. The Hennebique system, composed of concrete beams and floors with imbedded rods, is especially interesting as an example of girder construction without the use of arches, while the applications of expanded metal as a strengthening adjunct to concrete walls, partitions, etc., are numerous and successful.

Assuming, as practice warrants, that the concrete and steel act as one mass, it is necessary to consider the elasticity of both materials in computing the proportions of such structures, and Mr. Thacher shows in his paper that graphical methods lend themselves especially to these computations, and that the thrusts, bending moments, and shears are quickly and accurately found graphically, after which the application of a few simple equations, given in the article, enable the proper distribution of materials to be made.

Much of the present confidence in reinforced concrete has been the result of the exhaustive and valuable tests made by the Austrian Society of Engineers and Architects, and Mr. Thacher quotes freely from the report of the commission having those tests in charge. A list of important arches which have been constructed in various countries is also given and an especially valuable collection of data concerning materials and workmanship.

The question as to the durability of iron or steel when imbedded in concrete seems to be fairly well settled, and examples of structures which have been demolished after many years show that the concrete acts as a preservative and that little or no rust takes place.

Mr. Thacher quotes the saying of Mr. George S. Morison, that he "believes that we are now only at the beginning of concrete construction, and that if the results we hope for can be obtained with concrete structure with metal inside, the time will come when this will be the one method of building."

The Cost of Electricity in Buildings.

It is generally assumed that electricity can be supplied to buildings more cheaply than it can be generated by isolated plants, but that this is not always the case is shown in a carefully prepared paper read before the American Institute of Electrical Engineers by Mr. Percival R. Moses.

Mr. Moses has collected information from more than a hundred buildings of various sizes and types, and from these he has selected those from which the information was furnished with such a degree of detail as to render the conclusions reliable. The buildings selected include hotels, office buildings, loft buildings, department stores, and apartment houses, all in the city of New York, and since liberal access to the books of the establishments was permitted the data are of much interest.

In the investigation of the buildings the hourly variations in the demand for light and power were plotted in the form of curves, and in each case a proportional allowance made for depreciation, interest, and other fixed charges. A typical building was taken in each case, and as these cases include actual records of the cost of supplying the same buildings, under the same conditions, with electricity, both from their own isolated plants and by the central station, it certainly appears as if the comparisons have been made upon a fair basis.

In considering the isolated plant it must be remembered that in nearly, if not all,

such buildings a steam power plant must be maintained in any case, or at least steam must be used for heating, and if the steam power does not provide sufficient exhaust steam to warm the building live steam must be used. The installation of an isolated electrical plant is therefore only a partial increase in operating expense, in such cases, and not so great as it would be if the entire power plant had to be placed solely for the operation of the electric machinery.

We give here only the conclusions which Mr. Moses draws from each building considered by him, and the full data in each case will be found in his original paper. Taking a table which Mr. Moses has prepared for buildings using approximately from 825,000 kilowatt-hours per annum down to 40,000 kilowatt-hours, he shows that the costs per kilowatt-hour for isolated plants are as follows:

Large Hotel	1.66	cents.
Small Hotel	2.45	"
Apartments	4.70	"
Department Store	2.85	"
Small Store	4.10	"
Large Office Building	4.37	"
Small Office Building	5.06	"
Loft Building	2.60	"

When it is understood that the charges by the central station company, taken from the published reports, are, on an average, 10.6 cents per kilowatt-hour, and that the cost of production is about half this, it appears that under existing conditions in New York the private consumer can generate electricity at about the same cost, or even less cost than the central company, and that there is a manifest economy in the installation of the isolated electric plant.

Comparative Cost of Mechanical Traction.

IT is not often that such an excellent opportunity is offered for the comparison of costs of various forms of tramway traction as is given at the present time, since the Metropolitan Street Railway Company, operating electric, cable, and horse traction tramways in New York City, has given for publication in the *Street Railway Journal* a comparative exhibit of the receipts and expenses in detail of its various lines, similar to that which was published for the same lines one year ago. Since the track mileage is the same as it was a year ago a close comparison can be made of the growth in the system during the year, and the influence of this growth on receipts and expenses may to a great extent be observed.

"Taken as a whole, the Metropolitan system was operated last year at 15.18 cents per car mile, as against 15.83 cents in the previous year, and the earnings from operation have become 15.50 cents, as against 13.87 cents in 1898. The electric lines have made all of this increased earning power, and have, in addition, overcome a combined diminution on the horse and cable lines of 1.15 cents per car mile."

That the public responds promptly to increased facilities is shown in the fact that during the last year the company ran its cars over the same trackage nearly 42,000,000 miles, as against but 35,000,000 miles in the previous year, the new cars being also nearly double the capacity of the old ones. This resulted in an increase of nearly 25 per cent. in the passenger receipts, and an increase of about 3 per cent. in the receipts per car mile.

The percentages of operating expenses to passenger receipts of the three motive powers compare as follows:

	1898.	1899.	
Cable	47.8	50.8	per cent.
Electric	37.9	38.3	" "
Horse	65.3	69.8	" "
Total	53.3	49.4	" "

These figures give a fairly correct idea of the relative commercial value of the several methods of traction operated under nearly similar conditions, but some comments may be added in explanation.

The cost of electric motive power proper, excluding certain charges for horse connections upon some short lines operated with the electric lines, was 1.21 cents per car mile in 1898, and 1.57 cents in 1899, but it must be remembered that many of the cars operated in the latter year were much larger and heavier than the old cars. The new 70,000 h.p. station was not in operation at all during the year, and the advantage of economical power was therefore not yet obtained, and the temporary power stations, operated in connection with storage batteries are by no means adapted to handle the great loads economically, being taxed severely during certain hours of the day.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m* Boston, U. S. A.
Bridges. *m.* Chicago.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.

Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Accident.

A Lesson from a Building Accident. Describes the partial collapse of a building through the failure of a brick pier. Ill. 1000 w. Br Build—Sept., 1899. No. 29799 C.

Cow Sheds.

Construction of Cow Sheds. Sidney Villar. Extract. On the sanitary arrangements to secure freedom from tuberculosis and health of the animals. Suggestions for floors, ventilation, drains, etc. 2600 w. Arch, Lond—Sept. 8, 1899. 29678 A.

Dewey Arch.

The Dewey Arch. Illustrated description of the arch being built by the National Sculpture Society. 1200 w. Sci Am—Sept. 16, 1899. No. 29610.

Exposition.

A Visit to the Works of the Exposition of 1900 (Visite aux Chantiers de l'Exposition Universelle de 1900). Max de Nansouty. An account of the visit to various portions of the Exposition grounds by a party of members of the Society of Civil Engineers of France. 5000 w. Mem Soc Ing Civ de France—June, 1899. No. 29845 G.

The Austrian Government Building at the Paris Exposition (Das Oesterreichische Repräsentationshaus in der Weltausstellung, Paris, 1900). A description of the building, with plates showing the external and internal construction. 1200 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1899. No. 29817 D.

The Palaces on the Champs-Elysées (Les Palais des Champs-Elysées). E. Rouyer. Describing the progress of the construction of the large and small palaces of fine arts for the Paris Exposition. 2 articles. 6000 w. 2 plates. Génie Civil—Sept. 2, 9, 1899. No. 29825 each D.

Ice House.

Model Ice Storage House. Outlines and illustrates the plans and specifications of an ice-storage house at El Reno, Okla. 1500 w. Ice & Refrig—Sept., 1899. No. 29447 C.

Lighting.

The Luxfer Prisms (Les Prismes Luxfer). P. Grandjean. An examination of the theory of the use of prisms for improving the lighting of rooms, with examples showing the practical application. 8000 w. Rev Univ des Mines—Aug., 1899. No. 29841 G.

Pantheon.

The Paradox of the Pantheon. A. D. F. Hamlin. A study of ancient Roman vault construction, giving the writer's theory and the reasons that led him to adopt it. Ill. 2000 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29520 D.

Roof.

The Failure of the Chicago "Coliseum" Roof Arches. A statement of facts in regard to the cause of the fall of the twelve steel arches forming the main roof. Ill. 2500 w. Eng News—Sept. 14, 1899. No. 29617.

Roofing.

Felt and Gravel Roofing. Calls attention to some of the weak points and the way of avoiding them. Ill. 700 w. Met Work—Sept. 16, 1899. No. 29629.

Sand-Blast.

The Sand-Blast in Architectural Work. B. F. Fells. Illustrates and describes how to build and use a sand blast, and sand-sifting apparatus. 900 w. Am Arch—Sept. 9, 1899. No. 29537.

Theatre.

Recent Theatre Construction. Illustrated description of the metal work in a Jersey City theatre. 1500 w. Eng Rec—Sept. 16, 1899. No. 29654.

Vaults.

Vaults without Centerings. From *La Nature*. Illustrations and notes concerning the modern method employed for the construction of vaults. 1200 w. Sci Am Sup—Sept. 9, 1899. No. 29510.

HEATING AND VENTILATION.

Centrifugal Fans.

Centrifugal Ventilators. J. T. Beard. A review of designing practice, past and present, showing where the study of design should begin, the need of formulas correlating all the elements of the ventilator and the work, etc. Ill. 2800 w. Mines & Min—Sept., 1899. Serial. 1st part. No. 29459 C.

Hospital Ventilation.

Hospital Planning in Regard to Plenum Ventilation. William Henman. Read at the San. Inst. Congress. Describes the arrangements made for ventilating the Belfast Royal Victoria Hospital, and the advantages of the Plenum system. 1800 w. Brit Arch—Sept. 15, 1899. No. 29769 A.

We supply copies of these articles. See introductory.

Hot-Water.

An Exhaust Hot-Water Heating Plant. Illustrated description of the heating plant of a school building on Staten Island. 1500 w. Eng Rec—Sept. 23, 1899. No. 29904.

Tunnels.

See Railway Affairs, Permanent Way.

Vacuum System.

The Vacuum System of Heating. D. F. Morgan. On the advantages of this system, and the use of the vacuum producing air valve. 1900 w. Met Work—Sept. 16, 1899. No. 29628.

PLUMBING AND GAS FITTING.

Drainage.

House Drainage. Abstract of a paper by Lamorock Flower, on "The Drainage of Buildings Possessing No Open Space," read at the Congress of the Sanitary Institute, England. 800 w. Arch, Lond—Sept. 8, 1899. No. 29679 A.

Registration.

Registration of Plumbers Under the New York Building Law. Extract dealing with the registration of master plumbers. 1000 w. Eng Rec—Sept. 23, 1899. No. 29905.

Regulations.

Plumbing Regulations for Small Cities. Gives the ordinance of Quincy, Mass., a town of twenty thousand people. 1800 w. Dom Engng—Sept., 1899. No. 29753 C.

Water Supply.

Water Supply in a Large New York Residence. Illustrated description of a number of special features for the hot and cold water plumbing. 1300 w. Eng Rec—Sept. 16, 1899. No. 29656.

MISCELLANY.

Building Code.

Structural Regulations of the New York Building Law. Extracts from the new law modifying the previous requirements concerning the quality of materials, foundation, fire-proofing, iron and steel construction, floor loads, and the calculation of the strength of materials. 5800 w. Eng Rec—Sept. 16, 1899. No. 29657.

The Proposed New Building Code for New York City. Extracts from the sections which are of most interest to engineers, with other information bearing on the ordinance. 5500 w. Eng News—Sept. 14, 1899. No. 29622.

Mechanical Plant.

The Mechanical Plant of the Exchange Court Building, New York. Illustrated detailed description of the plant for heating, lighting and power purposes in a twelve-story office building. 2500 w. Eng Rec—Sept. 9, 1899. No. 29641.

CIVIL ENGINEERING

BRIDGES.

Aexander III.

The Alexander Bridge at Paris (Die Alexander-Brücke in Paris). Carl Bernhard. A very full account of the construction of the bridge, with many illustrations of details and erection. 6000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29804 D.

Atbara.

The Atbara Bridge (Die Atbara-Brücke). Inspector Frahm. An account of the circumstances attending the placing of the order for the Atbara bridge, together with a detailed description of the structure and its erection. Two articles, 4000 w. Stahl und Eisen—Aug. 1, Sept. 1, 1899. No. 29829 each D.

Centring.

Iron Centring Used in Constructing the Wienfluss Boulevard. Illustrates and describes the centring used in Vienna for covering the river Wien. 900 w. Engng—Sept. 15, 1899. No. 29791 A.

Concrete-Steel.

Concrete Steel Bridge Construction. Edwin Thacher. Considers in detail the construction of concrete steel arches and other structures, the materials, workmanship, etc., giving specifications for concrete steel bridges. Ill. 11700 w. Eng News—Sept. 21, 1899. No. 29747.

Erection.

American Bridge Erection. Brief illustrated description of the erection of a cantilever bridge over the St. John river, New Brunswick. 400 w. Engr, Lond—Sept. 15, 1899. No. 29784 A.

A Novel Method of Bridge Erection; Connecticut River Bridge, Northfield, Mass. Illustrated description of a curious method of erection without false works which was recently adopted in constructing a highway bridge. 1700 w. Eng News—Sept. 7, 1899. No. 29550.

The Northfield Bridge. Illustrated description of a cantilever structure with a main span of 360 ft., which was erected by a unique method which is explained. 4000 w. Eng Rec—Sept. 2, 1899. No. 29465.

Floating Bridge.

A Floating Bridge in the Philippines. B. F. Cheatham. A letter giving a short

description of a bridge constructed by the American army. Ill. 300 w. Eng News—Sept. 14, 1899. No. 29620.

High-Level Arch.

The Müngsten High-Level Arch Bridge. Illustrated description of interesting features. The floor of the bridge is about 354 feet above the surface of the river Wupper, which flows beneath. 1300 w. Sci Am—Sept. 9, 1899. No. 29508.

History.

The Bridge as a Religious Edifice. Extracts from records of the fourteenth to sixteenth centuries concerning a bridge in Barnstaple, England. 1200 w. Eng Rec—Sept. 16, 1899. No. 29650.

Lift Bridges.

New Scherzer Lift Bridges Over the Chicago River. Illustrates and describes the two new rolling lift bridges now building. 500 w. R R Gaz—Sept. 22, 1899. No. 29745.

Scherzer Rolling Lift Bridges Over the Chicago River. States the conditions on this river and gives illustrations of bridges to be constructed. 1200 w. Eng Rec—Sept. 23, 1899. No. 29902.

The Scherzer Rolling Lift Bridge Over the Fort Point Channel, Boston. Describes some of the details peculiar to this particular bridge, giving illustrations. 1500 w. R R Gaz—Sept. 8, 1899. No. 29566.

Rhine.

The New Bridge over the Rhine at Bonn (Die Neue Rheinbrücke bei Bonn). J. L. Algermissen. A very complete general description, with views of the completed structure, and sheets of details. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1899. No. 29818 D.

Tyne Bridge.

Proposed Bridge Over the Tyne. Illustrates and describes a cantilever type with span of 500 ft. in length. 1000 w. Engr, Lond—Sept. 15, 1899. No. 29786 A.

Viaducts.

Reconstruction of Railway Viaducts in Cornwall. Relates to the replacement or reconstruction of the many viaducts on the Great Western main line in Cornwall, without interruption of traffic. 1200 w. Builder—Aug. 26, 1899. No. 29454 A.

MATERIALS.

Asphalt.

An Albertite-like Asphalt in the Choctaw Nation, Indian Territory. Joseph A. Taff. History of the development and report of the material, and the associated rocks. 2000 w. Am Jour of Sci—Sept., 1899. No. 29420 D.

The Laboratory Production of Asphalts from Animal and Vegetable Materials. William C. Day. Describes experimental work, giving a statement of the results obtained, and discusses the origin of natural asphalts. 5500 w. Jour Fr Inst—Sept., 1899. No. 29486 D.

Buckling.

A New Formula for Buckling (Eine Neue Knickformel). F. von Emperger. A comparison of curves deduced from a number of existing formulas with the new formula of Ostenfeld. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 1, 1899. No. 29816 B.

Columns.

Calculation of Cast-Iron Columns. J. B. Nau. Gives diagrams for the rapid and correct calculation of cast-iron columns, explaining their use. 600 w. Eng News—Aug. 31, 1899. No. 29409.

Concrete.

On the Theory of Concrete. Discussion of paper by George W. Rafter. 3800 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29915 E.

CONSTRUCTION.

Breakwaters.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Lewis M. Haupt. Gives results of the curved breakwater at Aransas Pass, Texas, and the cause of the effective work; also considers the cost. The theory is explained. Ill. 5800 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29909 E.

Groined Arch.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Discussion of paper by Leonard W. Metcalf. 600 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29913 E.

Pile Driving.

Pile-Driving Formulas: Their Construction and Factors of Safety. Discussion of paper by Charles H. Haswell. 4200 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29912 E.

Pile Driving Formulas. Discussion of the reasonings and citations given in a paper by Charles H. Haswell in the Pro. of the Am. Soc. of Civ. Engs. 2800 w. R R Gaz—Sept. 1, 1899. No. 29405.

Tunnel.

The First Subaqueous Tunnel in Germany. Brief account of the tunnel in course of construction under the river Spree in Berlin. 900 w. Engr, Lond—Sept. 1, 1899. No. 29590 A.

HYDRAULIC AND MARINE.

Canal.

A Canal from Marseilles to the Rhone. Gives the general features of a new scheme to aid the trade of Marseilles,

with critical remarks concerning it. 1600 w. Engr, Lond—Sept. 8, 1899. No. 29-696 A.

The Dortmund-Ems Canal. An account of a waterway built at a cost of $18,000,000. 1200 w. Eng Rec—Sept. 23, 1899. No. 29900.

The Emperor at the Dortmund-Ems Canal and at the Union Works (Der Kaiser am Dortmund-Ems Kanal und auf der "Union"). With maps and profiles of the canal, and views of the canal lift and in the Union Works. 2500 w. Stahl und Eisen—Sept. 1, 1899. No. 29-832 D.

The Report of the Nicaragua Canal Commission. A full abstract of the report made to the President of the Walker Commission, as published in the *N. Y. Journal* for Sept. 10. 11200 w. Eng News—Sept. 21, 1899. No. 29750.

Dam.

East Canyon Creek Dam, Utah. M. S. Parker. Illustrated description of a rock-fill dam with a steel core in asphalt concrete. 2000 w. Eng Rec—Sept. 2, 1899. No. 29466.

The Chittenden Drum Dam. Illustrated description of a movable dam on the Osage River. 1500 w. Eng Rec—Sept. 16, 1899. No. 29648.

Dredge.

Marine Bucket-Dredge of 1000 Horse Power (Drague Marine à Godets de 1000 Chevaux). An illustrated description of the powerful dredge built for the Russian Government by Smulders, of Rotterdam, for use in the harbor of Vladivostock. 1000 w. 1 plate. Génie Civil—Aug. 19, 1899. No. 29820 D.

Driven Wells.

Sinking Driven Wells. A description of various methods employed in driving wells through earth and rock. 2300 w. Eng Rec—Sept. 16, 1899. No. 29653.

Dry Docks.

See Marine Engineering.

Filtration.

Clear Water from the Mississippi. Illustrated description of the system at Davenport, Ia., by means of which the water is rendered clear and potable. 900 w. Fire & Water—Sept. 9, 1899. No. 29541.

Test of a Mechanical Filter. Edmund B. Weston. Illustrates and describes the results of a three-months' test of filter recently installed for the East Providence, R. I., Water Company. 3000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29910 E.

Floods.

Predicting Floods in Rivers. A review of the method employed by the government hydraulic engineer of Queensland in foretelling floods on the Brisbane River. 1800 w. Eng Rec—Sept. 16, 1899. No. 29655.

Harbor.

Proposed New Docks and Collieries at Seaham Harbor. An account of the proposed works and favorable prospects of this port. 1100 w. Col Guard—Sept. 1, 1899. No. 29583 A.

Hydrography.

Hydrographic Observations and Measurements in Würtemberg (Die Hydrologischen Beobachtungen und Messungen in Württemberg). H. Gugenhan. An account of the surveys and river measurements made in Würtemberg for a number of years past, with interesting data as to methods of observing and recording. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29-807 D.

Irrigation.

Some Irrigation Appliances in the San Bernardino Valley, Cal. Notes from a publication of the U. S. Div. of Hydrography relating to the measurement of streams. Describes a floating weir, a measuring box, stop for diversion, and other appliances. Ill. 1300 w. Eng News—Sept. 7, 1899. No. 29552.

Lift Gates.

Twin Gates for the Fay Lake Reservoir, Arizona. Brief illustrated description of a vertical lift reservoir outlet gate of simple design, presenting some novel features. 250 w. Eng News—Sept. 7, 1899. No. 29558.

Reservoirs.

Flood-Water Channel, Altoona Reservoir. Illustrates main features of an unusual engineering work built to protect the basin from becoming clogged. 1200 w. Eng Rec—Sept. 23, 1899. No. 29903.

River Improvement.

The Improvement of the Big Sandy River. Illustrates and describes the type of movable dam used in the improvement of this river in West Virginia and Kentucky. 6000 w. Eng Rec—Sept. 9, 1899. No. 29638.

Run-Off.

The Volume and Velocity of Run-Off Water (Abfluss-Geschwindigkeit und Quantität). Rudolf Müller. An exposition of a new method of computing the run-off of rain water, with diagrams showing a graphical solution of given cases. 6000 w. Oesterr Monatschr f d Baudienst—Sept., 1899. No. 29819 D.

Surface Drainage.

The Drainage Problem of New Orleans. A statement of the unusual topographical conditions making surface drainage more difficult than sewerage. 1200 w. Eng Rec—Sept. 16, 1899. No. 29652.

Valves.

Outlet Valves at the Burrator Reservoir of the Plymouth Water Works. Edward Sandeman. Gives a general idea of the works and describes the manner in which the outlet pipes are controlled. Ill. 1300 w. Inst of Mech Engs—1899. No. 29723 D.

Water Supply.

Additional Water Supply Works for Dresden, Germany. Abstracted from a paper by Chief Engineer Vacherot before the Dresden Bezirksverein and published in *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrates and describes a pumping plant drawing water from infiltration wells, sunk along the banks of the river Elbe. 800 w. Eng News—Sept. 7, 1899. No. 29557.

A Remarkable Water Supply. Describes ridiculous works furnishing alleged filtered water to Aldeburgh-on-Sea, England. 600 w. Eng Rec—Sept. 16, 1899. No. 29646.

Auxiliary Water Supplies. Describes works for supplying water for other than domestic purposes in Bournemouth, Great Yarmouth, Calcutta, and Richmond. 1200 w. Eng Rec—Sept. 2, 1899. No. 29467.

New Tunnels, Intake Crib, and Pumping Stations, Chicago, Ill. Illustrated detailed description of extensive and important additions to the water supply system of this city. 4500 w. Eng News—Aug. 31, 1899. No. 29411.

New York Water Supply. Discusses the Ramapo water supply project. 3800 w. Engr, Lond—Sept. 15, 1899. No. 29782 A.

The London Water Supply: Its Future. Particulars of the possibilities of the Thames and its tributaries being able to meet the increasing demand. 1000 w. Engr, Lond—Aug. 25, 1899. No. 29435 A.

Water-Waste.

Water-Waste in the Olden Time. Editorial discussion of a criticism in a Boston journal in regard to the construction of the Roman aqueducts being better than the work of to-day. Gives facts showing the conditions were much worse in Rome than in any modern city. 1000 w. Eng Rec—Sept. 9, 1899. No. 29637.

Water-Works.

Private *versus* Municipal Ownership. C. W. Tooke. A review of the Danville, Ill., water case. 2500 w. Munic Engng—Sept., 1899. No. 29484 C.

Syracuse Water Works. W. R. Hill. General description with illustrations. 2700 w. Fire & Water—Sept. 9, 1899. No. 24542.

The Water-Works of Laodicea, Asia Minor. Edward Wegmann. Illustrated description of aqueduct and inverted siphon of stone blocks 7,000 meters long. 1200 w. Eng Rec—Sept. 16, 1899. No. 29647.

Three Engineering Reports on the Ramapo Project. Review of the main features of reports by G. S. Rice, E. E. McLean, and J. J. R. Croes on the proposal to sell New York 200,000,000 gals. per day at $70 per million gals. Mr. Croes gives important figures concerning leakage from old street mains. 2600 w. Eng Rec—Sept. 2, 1899. No. 29471.

Wave Pressures.

The Effect of Waves on Breakwaters. Extracts from a paper by William Shedd, read before the British Inst. of Civ. Engs. A description of the movement of concrete and rubble by wave action on a number of breakwaters. 1400 w. Eng Rec—Sept. 16, 1899. No. 29649.

MEASUREMENT.

Graphical Statics.

Graphic Methods of Determining the Pressure of Earth on Retaining Walls. P. R. Kirk. Considers pressure of earth against a retaining wall with a vertical surface, and pressure on a retaining wall when the surface of the earth is horizontal and level with the top of the wall. Ill. 2800 w. Builder—Sept. 9, 1899. No. 29680 A.

Planimeter.

A Simple Theory of the Polar Planimeter (Einfache Theorie des Polarplanimeters). Prof. Robert Land. A geometrical study of the planimeter, demonstrating the principle upon which its action depends. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29805 D.

Vienna.

The Plan of Vienna at the Time of the Second Turkish Siege (Der Plan von Wien zur Zeit der Zweiten Türkenbelagerung). S. Wellisch. A description of old surveys made before the siege of Vienna in 1683, comparing them with the Hirschvogel map of 1529, and with modern maps. 3000 w. Zeitschr d Oesterr Ingn Arch Ver—Aug. 11, 1899. No. 29811 B.

MUNICIPAL.

Asphalt.

Railway Asphalt Plant. An illustrated description of a portable plant for the preparation of asphalt used in paving, so that this industry may be extended to small cities and towns. 1800 w. Ry & Engng Rev—Sept. 2, 1899. No. 29491.

Baths.

Public Baths. E. Foster. Condensed from a paper read at meeting of the Assn. of Munic. and Co. Engs., at Cardiff. The improvements effected in

modern baths are discussed, and the kinds of baths best suited to the general public. 1600 w. San Plumb—Sept. 1, 1899. No. 29527.

Breslau.

Construction of Streets and Buildings in Breslau. Concerning the strictly enforced law regulating the construction of houses and streets, giving some of the requirements. 1000 w. U. S. Cons Repts, No. 530—Sept. 16, 1899. No. 29635 D.

Disinfecting.

The Disinfecting Station at Liverpool. James H. Fuertes. Describes a small plant where infected bedding, clothing and other articles are taken for treatment. 800 w. Eng Rec—Sept. 9, 1899. No. 29640.

Garbage Disposal.

Refuse Destructor Trials, Torquay, England. An account of four tests under different conditions of weather and refuse composition. 1400 w. Eng Rec—Sept. 2, 1899. No. 29469.

The Design of Refuse Carts. Report made by H. Law to the London County Council on the proper construction of these carts. 800 w. Eng Rec—Sept. 16, 1899. No. 29651.

Overflow Chamber.

A Storm Water Overflow, Denver. Illustrates and describes a spillway in connection with the Delganey Street Sewer Extension, and explains its operation. 600 w. Eng Rec—Sept. 9, 1899. No. 29639.

Paving.

Effect of Moisture on the Results of the Rattler Test of Paving Brick. W. Kendrick Hatt. Reports the results of tests to show less loss when wet than when dry. 900 w. Brick—Sept. 1, 1899. No. 29480.

Some Figures in Brick Paving. H. Foster Bain. Tables giving results obtained in some thirty cities, with an account of methods, materials, etc. 1800 w. Munic Engng—29483 C.

See Street and Electric Tramways.

Purification.

Improved Methods for the Purification of Sewage and Water, as shown in the Operation of the Municipal Plant at Reading, Pa. John Jerome Deery. Part first gives an illustrated detailed description of the sewerage system. 3800 w. Jour Fr Inst—Sept., 1899. Serial. 1st part. No. 29487 D.

Sanitation.

The Renovation of Bombay. Information from the report of the Special City Improvement Trust of Bombay showing energetic efforts to overcome the plague and to render the city healthful. 2000 w. Engr, Lond—Aug. 25, 1899. No. 29434 A.

Septic Process.

A Small Septic and Nitrification Sewage Treatment Plant Near Chicago. Alvord & Shields. An interesting account of the construction and working of a plant for a large golf and polo club house near Chicago. 2000 w. Eng News—Sept. 7, 1899. No. 29560.

Septic Tank and Sewage Filter Beds for the Essex Co. Lunatic Asylum, Verona, N. J. Describes the largest septic tank for the treatment of sewage thus far built in the United States. 750 w. Eng News—Sept. 7, 1899. No. 29559.

Sewage Disposal.

Modern Methods of Sewage Disposal. William Henry Preece. Extract from address before the Sanitary Inst. of Great Britain, at the Southampton meeting. Considers briefly the mechanical, chemical, and biological systems. 1800 w. Eng News—Sept. 14, 1899. No. 29621.

Sewer Ventilation.

Some New Theories on Sewer Ventilation. J. Morgan, in *The Surveyor*. Briefly reviews existing systems and describes the method approved by the author. 1200 w. San Plumb—Sept. 1, 1899. No. 29526.

Sprinkling.

Proposed Salt-Water Sprinkling Plant at Oakland, Cal. Plan submitted by M. K. Miller, Supt. of Streets, is presented, with the advantages claimed. 1500 w. Eng News—Sept. 7, 1899. No. 29554.

Street Cleaning.

Street Cleaning Machinery (Ueber Strassenwaschmaschinen). Th. Wayl. A discussion of the importance of washing from the surface of streets all dust and slime, and a description of machines for the purpose. 2000 w. Gesundheits-Ingenieur—Aug. 31, 1899. No. 29838 B.

MISCELLANY.

China.

England, America and Germany as Allies for the Open Door. Hon. John Barrett. Discussing the vast openings for engineering development in China, and the opportunity for the industrial nations which must supply her wants. 4000 w. Engineering Magazine—Oct., 1899. No. 29881 B.

Education.

Engineering Education as a Preliminary Training for Scientific Research Work. Storm Bull. Extracts from an address before the Am. Assn. for the Adv. of Science. On the fitness of the technically trained engineer for scientific research work. 1300 w. R R Gaz—Sept. 15, 1899. No. 29662.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Faults.

Some Interesting Points in the Theory and Practice of "Loop" Testing for Cable Faults. J. Wright. Calls attention to certain modifications and conditions for testing which may assist in obtaining accurate results. Ill. 2000 w. Elec Eng, Lond—Sept. 8, 1899. No. 29687 A.

Condensers.

Compensating Condensers in Telegraph Circuits. M. G. Simpson. Mathematical investigation of currents. 600 w. Elect'n, Lond—Aug. 25, 1899. No. 29456 A.

Signalling.

The Application of Electricity for Transmitting Orders (Ueber die Anwendung der Elektricität für Kommandozwecke). Dr. A. Raps. With numerous illustrations of indicators for transmitting orders from the bridge of a ship to the engine room. 4500 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29861 B.

Simultaneous Transmission.

Simultaneous Telegraphy and Telephony and the Construction of Apparatus Therefor. H. S. Webb. Considers the fundamental principles involved and describes the methods of arranging the apparatus. Ill. 3300 w. Am Elect'n—Sept., 1899. No. 29502.

Telegraph Lines.

Maintenance and Operation of Telegraph Departments. W. S. Glover. Extracts from a paper read at the July meeting of the Central Assn. of Railroad Officers. Suggestions for construction and repair of lines. 1100 w. Ry Age—Sept. 1, 1899. No. 29481.

Telephone Exchange.

The Independent Telephone Exchange of the LaFayette Telephone Company. Illustrated description of the equipment. 1600 w. Am. Elect'n—Sept., 1899. No. 29501.

Telephone Service.

The Storage Battery in Telephone Exchanges. Illustrates and describes a very successful installation of the Bell Telephone Co., of Philadelphia. 800 w. Elec Wld & Engr—Sept. 9, 1899. No. 29531.

Wireless Telegraphy.

Wireless Telegraphy During the Naval Manœuvres. A brief account of the service messages sent at a maximum distance of 60 sea miles. 500 w. Elect'n, Lond—Sept. 1, 1899. No. 29570 A.

DISTRIBUTION.

Mining Plant.

An Oerlikon Electric Mining Plant in Southern California. An illustrated detailed description of an electric plant for the distribution of power in and about the mines. 1800 w. Elec Wld & Engr—Sept. 23, 1899. No. 29760.

ELECTRO-CHEMISTRY.

Conversion.

The Phenomena Occurring at the Aluminum Anode (Ueber den Vorgang an der Aluminium Anode). K. Norden. A discussion of the subject of the electrochemical conversion of alternating into continuous currents by the use of aluminum anodes. Two articles. 8000 w. Zeitschr f Elektrochemie—Sept. 7, 14, 1899. No. 29866 each H.

Electrolysis.

On the Electrolysis of Thiosulphate of Ammonium. M. P. Pierron. Describes experiments carried out on aqueous solutions of thiosulphate of ammonium containing 17.5 per cent. of the anhydrous salt. 1200 w. Am Gas Lgt Jour—Sept. 4, 1899. No. 29493.

The Electrolysis of the Bromides of the Alkaline Earths (Ueber die Elektrolyse der Bromide der Erdalkalien). J. Sarghel. A very full account of experimental analyses, showing the close relation between the theory and the practical results. Two articles, 8000 w. Zeitschr f Elektrochemie—Sept. 7, 14, 1899. No. 29865 each H.

Furnace.

The Experimental Electric Furnace. Samuel Auchmuntz Tucker. Explains its value in scientific research and illustrates and describes experiments showing the intensity of the heat. 1500 w. Am Elect'n—Sept., 1899. No. 29500.

Statistics.

The Future of Electrochemical Technology (Ueber den Gegenwärtigen Stand der Elektro-chemischen Technik). Dr. W. Borchers. A tabulation of the present applications of electrochemistry, arranged by countries, and processes, together with an exhaustive commentary on the great future possibilities in metallurgy and industrial technology. 2500 w. Stahl und Eisen—Aug. 1, 1899. No. 29830 D.

Voltaic Cells.

Theory of Grotthus Applied to a Simple Voltaic Cell. W. R. Cooper. From a book on Primary Batteries soon to be published by *The Electrician*. Briefly

considers the explanation of the main facts of electrolysis, and discusses the reaction in a voltaic cell. Ill. 1700 w. Elect'n, Lond—Sept. 8, 1899. No. 29-684 A.

ELECTRO-PHYSICS.

Accumulator.

Batteries for High Pressure (Hochspannungsbatterien). Prof. Feussner. A description of the large storage battery of the Reichsanstalt, at Berlin, intended for a pressure of 10,000 volts. 3000 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29858 B.

Coherers.

A Quantitative Investigation of the Coherer. A. Trowbridge. Deals with the lowering of the resistance as a function of the quantity of electricity discharged through and the difference of potential on opposite sides of the coherer. 2200 w. Am Jour of Sci—Sept., 1899. No. 29419 D.

Earth Currents.

Cosmical Magnetism and Electricity. Arthur Edgar Cotterell. An examination of magnetic phases, giving illustrative charts. 900 w. Elec Rev, Lond—Aug. 25, 1899. No. 29432 A.

Observatories.

The Interference of Overhead Trolley Wires with the Work of Magnetic Observatories (Verhinderung einer Magnetischen Beeinflussung von Observatorien durch Benachbarte Elektrische Bahnen mit Oberirdischer Stromzuführung). S. Wächter. Referring especially to the action of the trolley lines in Strasburg, Alsace, upon the instruments in the observatory of the university. 1800 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29863 B.

Symbolism.

Symbolic Representation of General Alternating Waves and of Double Frequency Vector Products. Charles Proteus Steinmetz. A mathematical study of the vector analysis of alternating current phenomena, with discussion. 7000 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29602 D.

GENERATING STATIONS.

Austria.

The Power Plant on the Adige to Supply Botzen, Meran and Vicinity with Electricity (Die Etschwerke zur Versorgung der Städte Bozen, Meran, und Nachbarorte mit Elektricität). O. von Muller. A fully illustrated description of the plant by which a fall of 66 meters is used to generate 6000 h.p. for lighting, power, and carbide manufacture. 2500 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29853 B.

California.

The Auburn Station of the Central California Electric Company. Illustrates and describes an auxiliary hydraulic station running in parallel with another five miles away, giving particulars of the buildings and construction. 1000 w. Am Elect'n—Sept., 1899. No. 29499.

The Mount Whitney Water Power Electric Plant and Light Regulating Device. Describes the plant and its device for preventing consumers from burning too many lights. 1800 w. Eng News—Sept. 7, 1899. No. 29556.

Coblenz.

The Power House of the Coblenz Street Railway Company (Das Elektrizitätswerk der Coblenzer Strassenbahn-Gesellschaft in Coblenz). A brief description, with illustrations. 1800 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29859 B.

Commutation.

Commutation in Iron-Clad Armatures. An illustrated explanation of self-induction, and of how commutation is effected. 1800 w. Engr, U. S. A.—Sept. 1, 1899. No. 29488.

Development.

Water-Power Electrical Plants in the United States. B. C. Washington, Jr. On the great importance of the development, with description of a few important plants, and statistics of interest. 7000 w. Jour Fr Inst—Sept., 1899. No. 29485 D.

Factory Plant.

New Power Plant for the Lancaster Mills. Illustrated description of a three-phase electric power station for a large cotton mill, with a statement of the efficiency of the plant and an editorial on the remodeling of old mills. 3800 w. Eng Rec—Sept. 2, 1899. No. 29468.

Generators.

Direct-Alternating Generators. Alton D. Adams. Gives a brief review of existing conditions in electrical supply, the present tendency, and suggestions for the solution of the central station problem. 2500 w. Elec Wld & Engr—Sept. 9, 1899. No. 29533.

The Dynamos of the Luisenstrasse Electric Station at Berlin (Die Dynamomaschinen in der Centrale Luisenstrasse der Berliner Elektricitäts-Werke). Giving photographic views and scale elevations of the 1,000 kw. generators recently installed. 1000 w. 1 plate. Schweizerische Bauzeitung—Sept. 9, 1899. No. 29837 B.

The Regulation of Alternating-Current Generators. C. L. Cory. Read before the convention of the Pacific Coast Elec. Trans. Assn. at San Francisco. Dis-

cusses the drop through the armature, and the change in the strength of the magnetic field due to the demagnetizing action of the armature current. 2700 w. Jour of Elec—Aug., 1899. No. 29796.

King's Lynn.

The King's Lynn Electricity Works. Illustrated detailed description of a gas-driven electric-lighting installation in England. 4500 w. Elec Eng, Lond—Sept. 15, 1899. No. 29793 A.

Lachine Rapids.

Proposed Improvements at Lachine Rapids Works. On schemes proposed for preventing the entrance of ice into the head race, and to otherwise improve the plant. 1500 w. Can Engr—Sept., 1899. No. 29624.

Model Plant.

A Model Electric Light and Power Plant. Illustrates and describes notable features of the plant at Far Rockaway, now part of Greater New York. Ill. 1400 w. Eng News—Sept. 14, 1899. No. 29618.

Short-Circuit.

Experiments on the Short-Circuit Curves of Alternating Generators (Untersuchungen über die Kurzschlusskurve von Wechselstrom generatoren). A. Rothert. A long mathematical discussion with many diagrams based upon original experiments. Three articles. 7500 w. Elektrotech Zeitsch—Aug. 31, Sept. 7, 14, 1899. No. 29854, each B.

Switzerland.

Electric Light and Power Transmission at Aigle, Switzerland. Illustrates and describes an interesting installation showing how the varied wants of consumers are met notwithstanding the long distances and large area of distribution. 1000 w. Engr, Lond—Sept. 8, 1899. No. 29698 A.

Transformation.

A New Method of Determining Ratio of Transformation. J. R. Bibbins. Describes a simple and accurate method that is satisfactory when specially calibrated instruments are not available. 600 w. Elec Wld & Engr—Sept. 9, 1899. No. 29530.

Transformers.

On the Predetermination of the Regulation in Alternating-Current Transformers. A. E. Kennelly. Gives computations showing that the behavior of a transformer, under any given conditions of primary pressure and secondary load, may be predicted with all desired precision when the three transformer impedances have been found. 500 w. Elec Wld & Engr—Sept. 2, 1899. No. 29423.

Zurich.

The Extension of the Zurich Electric Station (Die Erweiterungsbauten des Elektricitätswerkes der Stadt Zürich). H. Wagner. With curves showing the increase in demand, and with views of the engine and boiler house, etc. Three papers. 3500 w. Schweiberische Bauzeitung—Aug. 12, 19, 26, 1899. No. 29835, each B.

LIGHTING.

Arc Lamps.

Iron Poles, Arc Lamps and Wires in Boston. Alton D. Adams. On the dangers to lamp-trimmers, the accidents and their causes, and the action taken by the Massachusetts legislature, which has led to the substitution of poles of wood for those of iron in Boston. 1500 w. Elec Wld & Engr—Sept. 23, 1899. No. 29763.

Cycle Lamps.

Electric Cycle Lamps. J. Warren. The present article deals with the type deriving its current from a storage battery attached to the frame of the machine. 900 w. Elec, Lond—Sept. 8, 1899. Serial. 1st part. No. 29736 A.

Glasgow, Scotland.

Electricity v. Gas in Glasgow. Concerning the charges made to consumers of electric light as compared with gas charges. 1400 w. Gas Wld—Sept. 2, 1899. No. 29575 A.

Incandescence.

Notes on the Incandescent Lamp Question (Beitrag zur Glühlampenfrage). Inspector Loch. An investigation of the endurance and maintenance of illuminating power, and also of the required increase of electrical energy. Tables and diagrams of the tests are given. 3000 w. Glaser's Annalen—Sept. 1, 1899. No. 29834 D.

Wiring.

Electric Lighting Undertakers and House Wiring. W. Fennell. Discusses the position of electric lighting authorities, with respect to wiring and wiring contractors, and with regard to free wiring and allied systems. Also editorial. 3000 w. Elec Engr, Lond—Sept. 1, 1899. No. 29572 A.

MEASUREMENT.

Condenser.

The Behavior of a Condenser of Large Capacity (Ueber das Verhalten eines Kondensators von Grosser Kapacität). Dr. A. Tobler. An account of investigations made with a condenser of 10 microfarads capacity. 1500 w. Elektrotech Zeitschr—Sept. 7, 1899. No. 29860 B.

See Electrical Engineering, Communication.

Conductivity.

The Determination of Standards of

Conductivity. Henry P. Harth. Remarks on the sources of error due to the method now used, with account of the method of using the Willyoung bridge adopted in the laboratory of John A. Roebling's Sons Co., at Trenton, N. J., and a description of new apparatus for determining standard bars of known conductivity. Ill. 1800 w. Elec Wld & Engr—Sept. 23, 1899. No. 29761.

Curves.

A New Apparatus for Showing the Successive Values of Alternating Current Curves (Ein Neuer Apparat zur Objektiven Darstellung der Momentanwerthe von Wechselstromkurven). W. Peukert. Describes an apparatus for showing the elements of the curve simultaneously to an audience by the use of a double form of Deprez mirror galvanometer. 1800 w. Elektrochem Zeitschr—Aug. 31, 1899. No. 29855 B.

Indicator.

A Frequency Indicator. George J. Yundt. Illustrates and describes an instrument based on the using of the repulsive effect of a magnetic field upon a live conductor perpendicular to it. 800 w. Elec Wld & Eng—Sept. 2, 1899. No. 29424.

Network Calculations.

The Equivalence of Triangles and Three-Pointed Stars in Conducting Networks. A. E. Kennelly. Gives a method which lessens the labor of calculating distributing networks. 1000 w. Elec Wld & Engr—Sept. 16, 1899. No. 29643

Permeameter.

A Permeameter for Shop Service. Cecil P. Poole. Gives a design for a permeability testing machine which was found to be thoroughly satisfactory under trying conditions of shop practice. 900 w. Am Elect'n—Sept., 1899. No. 29504.

Report.

The Report of the Physical Technical Institution from February, 1898, to January, 1899 (Die Thätgkeit der Physikalisch-Technischen Reichsanstalt in der Zeit vom 1 Februar, 1898 bis 31 Januar, 1899). A condensation of the full report, especially devoted to electrical measurements and comparisons made during the year. Two articles. 4000 w. Elektrotech Zeitschr—Aug. 31, Sept. 7, 1899. No. 29857, each B.

Resistance.

New Forms of Electrical Resistance Boxes (Neue Formen Elektrischer Widerstandssätze). Dr. Feussner. A description of boxes adapted both for measurement and regulation. 4000 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29852 B.

The Electrical and Mechanical Resistance of Dynamo Brushes. Gives an account of an experimental investigation undertaken in the electrical laboratory of Columbia Univ., by Messrs. Tibbals, Lowenberg, and Burns. The apparatus used is also described. 2800 w. Elec Wld & Engr—Sept. 16, 1899. No. 29645.

Standardization.

Report of the Committee on Standardization. Gives the report accepted by the American Institute of Electrical Engineers on June 26, 1899. 6000 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29601 D.

Units.

1. On the Rational Suppression of Irrational Systems of Units. E. Hospitalier, *L'Industrie Electrique*. 2. On Electrical Units. E. Blondel. Two communications and editorials discussing the C. G. S. units. 3500 w. Elec Wld & Engr—Sept. 23, 1899. No. 29764.

Wattmeter.

The New Siemens & Halske Wattmeter (Ueber ein Neues Wattmeter der Forma Siemens & Halske, A. G.). Dr. A. Raps. A paper before the Elektrotechnical Society, with numerous illustrations showing the construction of the instrument. 3000 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29864 B.

POWER APPLICATIONS.

Economy.

The Economy Effected by the Use of the Electric Motor Around Steel Plants, Furnaces and Foundries. Andrew E. Maccoun. States the requirements of power stations of this class, and describes some of the labor-saving devices, showing the advantages gained by the use of electric motors. 2800 w. Elec Wld & Engr—Sept. 9, 1899. No. 29529.

Governor.

Speed Regulator with Electrical Release (Geschwindigkeits regulatoren mit elektrischer Auslösung). H. Müller. A centrifugal governor is arranged to throw a switch in and out of gear to operate mechanism for moving the regulating mechanism of steam or hydraulic motors. 1200 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29850 B.

Machine Driving.

Electric Power in Engineering Works. Dr. Louis Bell. A masterly discussion of the reduction in internal expense and facilitation of shop operations through the use of electric driving. Illustrated by examples of the application of the methods recommended. 4000 w. Engineering Magazine—Oct., 1899. No. 29887 B.

Fly-Wheel Power of Motors. E. K. Scott. The need of thought and judg-

ment in driving certain types of machines. 1000 w. Elec Rev, Lond—Sept. 8, 1899. No. 29686 A.

Starter.

A Simple Starting Device for Polyphase Motors (Ein Einfacher Anlasser für Drehstrommotoren). Dr. F. Niethammer. With diagrams showing the arrangement of resistances adopted by various constructors. 1500 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29851 B.

TRANSMISSION.

Line Wire.

The Sag and Tension of Line Wire. Cary T. Hutchinson. Discusses the problem to determine the sag or tension, showing an error in the procedure generally used, and that the wire can with equal safety be strung much tighter. 600 w. Eng News—Aug. 31, 1899. No. 29407.

Power Transmission.

Three-Phase Power Transmission at St. Hyacinthe, Quebec. E. M. Archibald. Illustrates and describes the oldest plant in Canada employing this system. 2300 w. Can Elec News—Sept., 1899. No. 29525.

Safety Suspension.

Safety Appliance for High Pressure Transmissions (Sicherungen für Hochspannungsanlagen). Conr. Hesse. A description of the Gould device, by which a broken section is automatically disconnected, and rendered harmless. 1000 w. Elektrotech Zeitschr—Aug. 31, 1899. No. 29856 B.

Transmission Line.

Tests and Calculations for a Forty-Mile Aluminum Wire Transmission Line. F. A. C. Perrine. Read before the Pacific Coast Elec. Trans. Assn. Reports tests of the line of the Standard Electric Co., of California. 1200 w. Jour of Elec —Aug., 1899. No. 29797.

MISCELLANY.

Cost.

The Cost of Electricity in Some Typical Buildings in New York City. Percival Robert Moses. Shows that the isolated plant can be operated at a profit at rates lower than central station rates. Also discussion. 16800 w. Trans Am Inst of Elec Engs—June and July, 1899. No. 29603 D.

Efficiency.

Theoretical v. Practical Efficiency. Sydney F. Walker. Considers what is meant by efficiency, discussing what he calls the efficiency of transformation and the commercial efficiency. 2000 w. Elec Rev, Lond—Sept. 1, 1899. No. 29574 A.

Electrical Interests.

The Advisability of Concentrating the Control of All Municipal Electrical Interests Under One Head. Morris W. Mead. Read before the Nat. Assn. of Munic. Elect'ns, at Wilmington, Del. Discussion of the subject. 1200 w. Elec Rev, N. Y.—Sept. 6, 1899. Serial. 1st part. No. 29523.

Electrical Work.

The Licensing of Employés on Electrical Work, and Improving the Quality of the Work and Material. William Brophy. Read before the Nat. Assn. of Munic. Elect'ns, at Wilmington, Del. Part first discusses the qualifications of the men occupying important positions and the work undertaken. 2300 w. Elec Rev, N. Y.—Sept. 13, 1899. Serial. 1st part. No. 29616.

Safety.

The Prevention of Injury to Man in Electric Plants (Die Sicherheit des Menschen gegenüber Elektrischen Anlagen). Dr. H. Kath. A discussion of what may be considered normal conditions of safety, and the extent to which such conditions may be violated in electrical plants. 3500 w. Elektrotech Zeitschr—Aug. 24, 1899. No. 29849 B.

GAS ENGINEERING

Acetylene.

Acetylene Gas for Lighting. H. L. Tyler. Considers the candle power, generation and cost. Also gives tables, useful in estimating the expense of lighting by acetylene. 1200 w. Dom Engng—Sept., 1899. No 29754 C.

On the Rapidity of Detonation of Acetylene (Sur la Vitesse de Détonation de l'Acétylène). MM. Berthelot and Le Chatelier. A communication to the French Academy giving the results of experiments upon the rate of propagation of ignition at pressures from 5 to 30 atmospheres. 3000 w. Comptes Rendus —Aug. 28, 1899. No. 29840 D.

Researches upon the Metallic Derivatives of Acetylene (Recherches sur les Dérivés Métalliques de l'Acétylène). MM. Berthelot and Delépine. An important communication to the French Academy, giving the detailed results of a long series of experiments. 5000 w. Comptes Rendus—Aug. 14, 1899. No. 29839 D.

Some Drawbacks to the Use of Acetylene. J. Verters, in *Chem. Zeitung.* Calls attention to various inconveniences. 900 w. Sci Am—Sept. 23, 1899. No. 29727.

Coal Distillation.

Coal Distillation and Gas and Fuel Production in Bulk. Extracts from the address of George Bielby, at meeting of the Society of Chemical Industry. Considers the remedies for smoke combustion by the production of smokeless fuels, and the effect of coal distillation. 3000 w. Jour Gas Lgt—Sept. 5, 1899. No. 29606 A.

Coke-Oven Gas.

Illuminating Gas from Coke Ovens. Carl Schmidt, in *Jour. für Gasbeleuchtung.* On tests made in the German coal regions with the conclusion that by using the proper kind of oven and coal an illuminating gas can be made much more cheaply than from retort furnaces and scarcely inferior in quality. 1800 w. Pro Age—Sept. 15, 1899. No. 29633.

The Application of Coke Oven Gas for Motive Power (Die Verwendung der Koksofeugase zum Motorischen Betriebe). A. von Thering. A review of Disdier's paper before the Iron and Steel Institute, giving analyses of many samples of gases. 2500 w. Stahl und Eisen—Sept. 1, 1899. No. 29833 D.

Furnace Gas.

The Direct Utilization of Blast Furnace Gases in Explosion Motors (Utilisation Directe des Gaz des Hauts Fourneaux dans les Moteurs à Explosion). Aug. Dutreux. A general discussion of the subject, based on the paper of Prof. Meyer, of Göttingen. 2000 w. Génie Civil—Aug. 26, 1899. No. 29824 D.

Gas Firing.

Domestic Gas Firing and Its Relation to Heating and Ventilation. Extract from address by George Beilby, at recent meeting of the Society of Chemical Industry, bearing on the present position of this subject. 3500 w. Jour Gas Lgt—Aug. 29, 1899. No. 29507 A.

Gas Traction.

See Street and Electric Tramways.

Lamp.

Illumination by Alcohol (L'Eclairage par l'Alcool). M. L. Denayrouze. A paper before the Society of Civil Engineers of France, describing the use of carburetted alcohol lamps for use in connection with incandescent mantles. 2500 w. Mem Soc Ing Civ de France—June, 1899. No. 29846 G.

Lamp-Black.

Lamp-Black from Coal Gas and Acetylene. Georges F. Jaubert, in *Jour du Gaz et de l'Electricité.* Notes on the industrial preparation of blacks in general and their use, with particulars concerning the beautiful black of exceptional fineness, known as acetylene black. 2000 w. Pro Age—Sept. 15, 1899. No. 29634.

Massachusetts.

The Bay State Gas Situation. An explanation of the present condition and the transactions connected. 3800 w. Am Gas Lgt Jour—Sept. 11, 1899. No. 29549.

Photometer.

Portable Photometer as Used in the Standard Oil Company's Test. Views and descriptions of an interesting and unique instrument. 600 w. Eng News—Sept. 7, 1899. No. 29551.

Power Gas.

A Study of Various Combustible Gases (Etude sur Divers Gaz Combustibles). M. A. Lencauchez. A critical comparison between producer gas and gas distilled from wood, for heating and power purposes. An important paper. 20000 w. 2 plates. Mem Soc Ing Civ de France—May, 1899. No. 29847 G.

The Production and Use of Combustible Gases (La Production et l'Emploi de Divers Gaz Combustibles). M. Lencauchez. A supplementary communication to the author's previous paper, describing a number of methods of generating gas for heating and power. 7500 w. Mem Soc Ing Civ de France—June, 1899. No. 29848 G.

Pressure.

Notes on the Working of a Self-Loading Governor. W. Whatmough. Read before the Manchester (Eng.) District Institution of Gas Engs. Gives the results of the practical working of the self-loading governor in use at the Heywood Gas Works. Ill. 4700 w. Jour Gas Lgt—Sept. 12, 1899. No. 29740 A.

Separator.

Decauter-Separator for Tar and Liquor. M. G. Ymonet. Read before the Société Technique du Gaz en France, 1899. Abstract. Illustrates and describes the method. 500 w. Gas Wld—Aug. 26, 1899. No. 29430 A.

Supply.

A New Policy in Gas Supply. The policy announced by the High Wycombe Gas Light and Coke Co., which marks a new era in the history of the gas industry. 800 w. Builder—Sept. 16, 1899. No. 29794 A.

Tar.

The Prevention of the Thickening of Tar. Abstract translation of a paper read by Herr G. Siegel before the German Assn. of Gas and Water Engs., at Cassel. States difficulties arising from this trouble, the researches made, and the author's manner of working his retorts, which has resulted in freedom from all troubles arising from thick tar. 3700 w. Jour Gas Lgt—Sept. 5, 1899. No. 29605 A.

MARINE AND NAVAL ENGINEERING

Armament.

Proposed Armament for Our Three Latest Battleships, "New Jersey," "Georgia," and "Pennsylvania," with favorable comment. 1400 w. Sci Am—Sept. 9, 1899. No. 29509.

Auxiliary Machinery.

Electric Auxiliary Machinery in the United States Navy. Alton D. Adams. An examination of the value of electric driving in warships, showing most favorable results. 4400 w. Engr, Lond—Sept. 8, 1899. No. 29697 A.

The Use of Steam Auxiliary Machinery for War Ships. Lieut. J. K. Robison. Reviewing the comparative claims and performance of steam and electric auxiliaries, and giving especial attention to the increase of economy secured by recent improvements in design and operation of steam motors, of which many fine illustrations are given. 5000 w. Engineering Magazine—Oct., 1899. No. 29888 B.

Ballasting.

Ballasting. H. P. Wortley. Written for the Shipmasters' and Officers' Society, London. A discussion of this subject and of the evils of sending ships to sea insufficiently immersed. 2500 w. Naut. Gaz—Sept. 7, 1899. No. 29524.

Battleship.

A New Type of Battleship—The French Henri Quatre. Illustrated description of an experimental ship built by France. 1400 w. Engr, Lond—Sept. 8, 1899. No. 29699 A.

Coast Signals.

Methods Used in Placing the Skeleton Steel Beacon Coast Signals. Brief description of these beacons, designed for use in shoal water as day marks and for survey stations. 700 w. Eng News—Sept. 7, 1899. No. 29561.

Cruiser.

The Austro-Hungarian Cruiser Zenta. Brief description and report of trials of this twin-screw cruiser. Of interest especially as regards the working together of a group of eight Yarrow boilers, which type has been adopted in the Austrian navy for this class of cruiser. Illustrates the triple-expansion engines. 900 w. Engr, Lond—Aug. 25, 1899. No. 29439 A.

The Austro-Hungarian Cruiser Zenta. Illustrates the general arrangement of the boilers and stoke holds. 200 w. Engr, Lond—Sept. 1, 1899. No. 29591 A.

Disaster.

The Bullfinch Disaster. Gives a discussion of the accident to H. M. destroyer Bullfinch, which occurred July 21. 3500 w. Engng—Aug. 25, 1899. No. 29443 A.

The Bullfinch Disaster. Gives a reduced facsimile of the connecting rod and discusses why the rod broke. Deals with the design of the rod and the material. 2800 w. Engr, Lond—Sept. 1, 1899. Serial. 1st part. No. 29589 A.

Dry Docks.

Responsibility of Dry Docks. Concerning a recent case in the Liverpool assize court, which allowed no damages for the collapse of a vessel in dock where exceptional construction had not been provided for. 1300 w. Marine Rev—Sept. 14, 1899. No. 29632.

Germany.

The Development of German Shipbuilding. Rudolph Haack. Herr Haack's third paper deals with the shipyards on the shores of the Baltic, and gives many fine illustrations of yards and their products. 4500 w. Engineering Magazine—Oct., 1899. No. 29882 B.

Marine Engines.

Some Grand Rapids Marine Engines. Baxter Aslakson. The Wolverine gasoline engine is illustrated and described in detail. 2000 w. Am Mach—Sept. 14, 1899. No. 29612.

Marine Machinery.

Test of the Machinery of the Minnesota Steamship Company's Steamer "Pennsylvania." B. C. Bryan and W. W. White. Illustration and general description of the vessel and its equipment, with accounts of the tests for determining the adaptability of underfed stokers and the economic results. 4500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29392 H.

Naval Manoeuvres.

Outline of the British Naval Manœuvres Recently Concluded. States the purpose of the manœuvres and gives the official programme, with description of the fleets. Ill. 1600 w. Marine Engng—Sept., 1899. No. 29495 C.

Oceanic.

Particulars of the Marine Monsters Oceanic and Great Eastern. Illustrates and describes these two large vessels, giving information of details in the construction of the Oceanic. 2800 w. Marine Engng—Sept., 1899. No. 29494 C.

The "Great Eastern" and the "Oceanic"—A Comparison. An illustrated article bringing out the great progress made during the last forty years in the building of transatlantic liners.

2000 w. Sci Am—Sept. 23, 1899. No. 29726.

The "Oceanic." Illustration and description of the internal fittings of this great White Star Liner. 2500 w. Engng—Sept. 1, 1899. No. 29596 A.

The White Star Twin-Screw Steamer Oceanic. Illustrated description of interior arrangements and decorations. 2000 w. Engr, Lond—Sept. 15, 1899. No. 29783 A.

Propeller Shafts.

The Manufacture of Propeller Shafts. D. B. Morison. Considers the material, workmanship, corrosion, and wearing down of stern bush as the chief factors governing the life of a propeller shaft. Ill. 2500 w. Engng—Sept. 1, 1899. No. 29592 A.

Shipwrecks.

The Shipwrecks of a Year. Editorial on the gross reduction of the mercantile marine in 1898, as given in Lloyd's Registry. 800 w. Engng—Sept. 1, 1899. No. 29595 A.

Signalling.

See Electrical Engineering, Communication.

Steamships.

The Twin-Screw Steamer Bavarian of the Allan Line. Illustration and description of a fine steamer to run between Liverpool and Canadian ports. 1200 w. Engr, Lond—Aug. 25, 1899. No. 29437 A.

Steering.

The Steering of Ship (Ueber das Steuern der Schiffe). C. W. Suppán. An examination into the manner in which the rudder acts upon the water in steering, together with a discussion of modern steering machinery. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 1, 1899. No. 29815 B.

Torpedo Boats.

New U. S. 30-Knot Torpedo Boats Dahlgren and T. A. M. Craven. Dimensions, descriptions, plans, and views of engines. 2800 w. Marine Engng—Sept., 1899. No. 29496 C.

Vibrations.

The Vibrations of Ships, their Causes and Means of Reduction (Schiffsschwingungen, ihre Ursachen und Kritik der Mittel zu ihrer Verminderung). Herr Berling. A general review of the results of investigations made with the Schlick recording apparatus, together with a discussion of the nature of the vibrations, and of the Taylor-Schlick method of balancing engines. Two articles. 2 plates. 10000 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 26, 1899. No. 29800 each D.

Warships

The Logical Arrangement of the Motive Power of Warships. George W. Melville. Full paper, complete discussion and author's reply. 19800 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29395 H.

Wave Resistance.

A Study of the Energy of the Bow Wave. Marston Niles. The paper presents the writer's reasons for believing that prevailing opinions, with their mathematical basis, are in almost every respect erroneous, and the conclusions therefore incorrect. Considers the transverse bow wave. Ill. 16500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29393 H.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Automotor Cars.

See Railway Affairs, Motive Power.

Club.

The Automobile Club of France. Francis P. Mann. Gives the history of the club and the work carried out. 2700 w. Elec Rev, N. Y.—Sept. 13, 1899. No. 29615.

Delivery Wagons.

French Trials of Electric Delivery Wagons. Illustrates the two electric wagons that successfully withstood the test made at Versailles. 650 w. Elec Wld & Engr—Sept. 23, 1899. No. 29762.

Hansom.

A New Type of French Automobile Hansom. Illustrates and describes a vehicle exhibited at the recent Exposition in Paris, which is arranged to carry four people and is mounted from the front. 700 w. Elec Wld & Engr—Sept. 16, 1899. No. 29642.

Liverpool Trials.

Auto-Car Trials at Liverpool. Letter to the editor containing remarks and impressions in reference to the hill-climbing trials on July 31. 2200 w. Engr, Lond—Sept. 1, 1899. No. 29588 A.

Parade.

The Automobile Parade at Newport, R. I. Spencer C. Crane. A brief account of this parade with illustrations of the floral decorations. 800 w. Elec Wld & Engr—Sept. 16, 1899. No. 29644.

Steering.

A Study of Double-Pivot Steering Devices (Etude sur la Direction à Deux Pivots). C. Bourlet. A general ex-

amination of the various methods of connecting the steering wheels of automobiles, by which the desired varying inclination is obtained. The practice of various builders is given. Two articles. 4500 w. Génie Civil—Sept. 2, 9, 1899. No. 29826 each D.

Tests.

Commission's Report on the Test of Heavy Motor Vehicles, Held at Versailles, in October, 1898. Gives the conclusions of the commission and tabulated report of the tests made. 900 w. Eng News—Sept. 7, 1899. No. 29553.

HYDRAULICS.

Pumping Engine.

The New 20,000-Gallon Pumping Engine of the Indianapolis Water Company. Illustration and report of test made by W. F. M. Goss. 1200 w. Fire & Water —Sept. 9, 1899. No. 29543.

Valves.

Brindley's Hydraulic Working Valve. Illustrates an ingenious invention in pressure valves for use with heavy hydraulic machinery. 600 w. Engr, Lond—Sept. 15, 1899. No. 29787 A.

MACHINE WORKS AND FOUNDRIES.

Axles.

Making Wrought-Iron Axles. Stephen Uren. Read at the convention of the Nat. R. R. Master Blacksmiths' Assn. Describes details in the manufacture of good axles. 1900 w. Ry Age—Sept. 8, 1899. No. 29540.

Brass.

Methods of the Brass Foundry. Extracts from a paper on "The History and Technics of Bronze Founding," read at the Pittsburg meeting by James Powell, indicating that in the making of statues and other cored work the processes of the Greeks and Etruscans were substantially those of to-day. 1000 w. Ir Trd Rev—Sept. 21, 1899. No. 29739.

Chemistry.

Chemistry in Machine Shop Practice. Warren E. Willis. Gives a list of chemicals and their uses in practical work. 2200 w. Mach, N. Y.—Sept., 1899. No. 29399.

Cylinder Boring.

Boring an Engine Cylinder in the Sierra Nevada Mountains. H. H. Kelley. An account of difficulties in starting up a mine engine that had been stopped for more than a year and not left in a proper condition. Ill. 2000 w. Engr, U. S. A.—Sept. 1, 1899. No. 29489.

Dies.

An Automatic Bending Die. H. E. Harris. Illustrated description. 500 w. Am Mach—Aug. 31, 1899. No. 29402.

Making a Compound Watch-Wheel Die. Lundvall and Klute. Illustrated detailed description. 1800 w. Am Mach—Sept. 7, 1899. No. 29515.

Drawing Office.

The Drawing Office. C. E. Hodgkin. Read before the Falcon Works Engng. Soc. On the importance of good delineation, the functions of draughtsmen, etc. 2500 w. Prac Engr—Sept. 1, 1899. Serial. 1st part. No. 29571 A.

Explosions.

Explosions in India-Rubber Works. Editorial discussion of the processes in which carbon bisulphide is used and their danger, and the responsibility of the government. 1700 w. Engng—Sept. 1, 1899. No. 29593 A.

Foundry Practice.

Modern Iron Foundry Practice. George R. Bale. Part first discusses the construction of moulds, and moulding sand. 2300 w. Prac Engr—Sept. 8, 1899. Serial. 1st part. No. 29682 A.

Gears.

Bevel Gear Cutting at the Pope Mfg. Company. Part first illustrates and describes the Brown & Sharpe bevel gear generating machine. 900 w. Ir Age—Sept. 7, 1899. Serial. 1st part. No. 29505.

The Octoid System of Gear Teeth. An illustrated explanation of the term "octoid," and its difference from the involute system. 600 w. Am Mach—Sept. 7, 1899. No. 29513.

Iron Works.

The Union Iron Works. J. Richards. Illustrates and describes the equipment of these works at San Francisco, giving interesting information. 2000 w. Mach, N. Y.—Sept., 1899. No. 29398.

Lathes.

A New English Lathe. James Vose. Illustrates and describes the Tangye engine lathe. 700 w. Am Mach—Sept. 14, 1899. No. 29613.

Loam.

Sweeping a Gear in Loam-Teeth to Be Cut Over After Casting. R. H. Palmer. Gives an illustrated detailed description of the work. 2500 w. Am Mach—Sept. 14, 1899. No. 29611.

Locks.

Ancient Egyptian versus Modern Pin Locks. Illustrates and describes the Egyptian pin lock and the modern Yale lock, showing the improvements made. 1600 w. Sci Am—Sept. 2, 1899. No. 29636.

Machine Driving.

See Electrical Engineering. Power.

Molding.

Molding Columns. R. H. Palmer. Il-

lustrates and describes various methods. 2000 w. Foundry—Sept., 1899. No. 29765.

Premium Plan.

The Premium Plan at the Works of A. L. Ide & Sons. Herman Fernstrom. Describes the system used at these works, considering it more simple than most of the systems presented. 2200 w. Am Mach—Sept. 7, 1899. No. 29514.

Punching.

Punching and Shearing Small Spring Steel. C. E. Quimby. Illustrated description of a sub-press and set of dies for punching and cutting off flat spring-tempered steel about ⅛ inch wide and 1-64 inch thick. 900 w. Am Mach—Sept. 7, 1899. No. 29516.

Shrinkage.

Shrinkage Strains. R. D. Moore. Explains the cause of these strains and discusses the casting of what was known as the Rodman cannon. 1500 w. Foundry—Sept., 1899. No. 29766.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. The first of a series of papers showing the progress of concentration and specialization, and the tendency to use automatic machinery kept in order by skilled tool-makers, but operated by ordinary labor. Illustrations of many historical tools are given in the opening article of the series. 3500 w. Engineering Magazine—October, 1899. No. 29884 B.

Slot Machinery.

Slot Machinery. R. I. Clegg. Explains the coin attachment and its working. 1200 w. Am Mach—Sept. 14, 1899. No. 29614.

Standardizing.

Standardizing in Engineering Construction. Sir Benjamin C. Browne. A forcible statement, by the manager of one of the largest British engineering works, of the changes introduced by widening competition; showing very plainly the direction of mechanical evolution and the necessity for reorganizing works in accord with it. 3500 w. Engineering Magazine—Oct., 1899. No. 29883 B.

Tools.

Some Manchester Tools. James Vose. Photographs and particulars of several machine tools built by Messrs. Beyer, Peacock & Co., Limited, which have attracted attention by reason of their efficiency. 1000 w. Am Mach—Aug. 31, 1899. No. 29400.

Works Management.

The Laws of Profit. R. H. Smith. An examination of the elementary general laws that govern profit-making business. 3500 w. Engr, Lond—Sept. 8, 1899. Serial. 1st part. No. 29695 A.

Works Management for the Maximum of Production. J. Slater Lewis. The first of a series of articles devoted to a discussion of the need and nature of methods to make supervising talent, labor and equipment yield the largest output at lowest cost. 4500 w. Engineering Magazine—Oct., 1899. No. 29885 B.

SPECIAL MOTORS.

Blowing Engines.

Recent Improvements in Power Plants, Especially in Blowing Engines (Neue Aufgaben des Kraft betriebes in Hüttenwerken, insbesondere des Gebläsebaues). A. Riedler. Discussing especially the application of the gas engine to the driving of blast-furnace blowing engines; and the modifications to produce the best results in such cases. 3000 w. Stahl und Eisen—Aug. 15, 1899. No. 29831 D.

Gas Engine.

A Type of Three-Cylinder Vertical Gas Engine. Views illustrating the general construction of the 650-K.-W.-gas-engine which has been operated for some time at the works of the Westinghouse Elec. & Mfg. Co., Pittsburg, Pa., with description. 1000 w. Eng News—Sept. 21, 1899. No. 29751.

Latest Type of Otto Gas Engine. Brief illustrated description of this engine with the latest improvements, adapting it especially to larger sizes. 500 w. Am Mfr & Ir Wld—Aug. 31, 1899. No. 29421.

The Westinghouse Gas Engine. Illustrated description of the more important features of this engine, and its working. Also extract from a pamphlet issued by this company on "The Present Position of the Gas Engine." 2500 w. R R Gaz—Sept. 15, 1899. No. 29661.

Gasoline Engine.

Gasoline Engine, 60 K. W., 220 Volt, Watertown, S. D., Central Station. F. W. Springer. Illustrates and describes a plant consisting of two Otto engines, and explains the conditions which led to this solution of the problem. 1200 w. Elec Wld & Engr—Sept. 9, 1899. No. 29528.

Petroleum-Spirit.

A New Petroleum-Spirit Motor-Vehicle. Brief illustrated description, giving details of some parts of the construction of a vehicle of the four-wheeled dog-cart type. 800 w. Ind & Ir—Sept, 1, 1899. No. 29598 A.

Testing.

Hydrocarbon Engine Testing. Plant of the Ohio State University. William T. Magruder. Presented at the Columbus meeting of the Soc. for the Pro. of Engng. Education. Describes a plant

for the testing of gas, gasoline and oil engines as student exercises and research work. 1200 w. Mod Mach—Sept., 1899. No. 29425.

Thermal Engines.

The Diesel Motor and Thermal Engines (Le Moteur Diesel et les Moteurs Thermiques). Donat Banki. An exhaustive discussion of the thermal action of internal combustion and explosion motors, and an inquiry into the conditions which conduce to highest efficiency. An important paper. 4000 w. Génie Civil—Aug. 19, 1899. No. 29821 D.

MATERIALS OF CONSTRUCTION.

Chains.

The Theory and Calculations for Link Chains (Beitrag zur Theorie und Berechnung der Gliederketten). R. Edler. An exhaustive mathematical discussion of the strength of chains made of elliptical links, showing the nature and extent of the stresses and strains, and deriving formulas for practical application. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 18, 25, 1899. No. 29814 each B.

Copper Alloys.

See Mining and Metallurgy, Copper.

Helical Springs.

Carrying Capacity and Deflection of Helical Springs of Round Steel. W. B. Travell. Gives curve diagrams plotted according to the formulæ of J. Begtrup. 350 w. Am Mach—Sept. 21, 1899. No. 29758.

Lubrication.

Graphite and its Application as a Lubricating Material (Grafit und seine Verwendung als Schmiermittel). F. Wagner. A paper giving data concerning the use of graphite in steam cylinders and valve chests of steam engines, showing its value for lubrication. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1899. No. 29806 D.

Metallography.

Notes on the Molecular Constitution of Iron (Einiges über das Kleingefüge des Eisens). E. Heyn. A discussion of some of the latest results obtained by the study of micro etchings of polished sections of iron. Many microphotographs of sections are given. Two papers. 2 plates. 5000 w. Stahl und Eisen—Aug. 1, 15, 1899. No. 29828 each D.

Steel Wire.

The Elastic Properties of Steel Wire. Archer Dave Keigwin. Excerpt from Proceedings of Inst. of Civ. Engs. Describes experiments undertaken to determine the behavior of annealed and unannealed steel wire when subjected to tensile stress. 2000 w. Mech Wld—Aug. 25, 1899. No. 29453 A.

Strength.

The Influence of Temperature Upon the Strength of Metals (Influence de la Temperature sur les Propriété Résistantes des Metaux). A translation into French by M. S. Jordan, of Prof. Ledebur's experiments made at the Charlottenburg testing laboratory. 18,000 w. Bull de la Soc d'Encour—Aug., 1899. No. 29844 G.

Testing Metals.

Work of the International Association for Testing Metals. Mansfield Merriman. Address of the Chairman of the American section of the Assn. at the Pittsburg meeting. Reviews briefly the progress of knowledge concerning the properties of materials of construction, and the formation of the International Association for Testing Materials. 900 w. Mod Mach—Sept., 1899. Serial. 1st part. No. 29426.

POWER AND TRANSMISSION.

Aerial Tramways.

Aerial Tramways in British Columbia. B. C. Riblet. An account of the building and operation of aerial tramways in West Kootenay. 1500 w. Can Min Rev—Sept., 1899. No. 29429 B.

Air Compressor.

A High Grade Australian Air Compressor. Illustrates and describes an air compressor installed at the Long Tunnel gold mine of Walhalla, Victoria. 1500 w. Am Mach—Aug. 31, 1899. No. 29401.

Belts.

Belts. Horace K. Sharpe. Suggestions for their care and regulation. The size of the pulley and speed of the belt in relation to the transmission of power, etc. 2500 w. Engr, U. S. A.—Sept. 15, 1899. No. 29674.

Coal Handling.

A Simple Coal-Handling Equipment. James F. Hobart. Illustrates and describes a portable and easily managed device which is in operation on South street, New York. 700 w. Am Elect'n—Sept., 1899. No. 29503.

Compressed Air.

Compressed Air and its Distribution for Power Purposes in Paris. V. Popp. Deals with how it is produced, its numerous applications and its cost. Ill. 4200 w. Compressed Air—Sept., 1899. Serial. 1st part. No. 29518.

Governor.

See Electrical Engineering. Power Applications.

Power Economy.

Selecting Economical Means for Increasing the Power of a Plant. H. H.

Kelley. Discusses the means of determining whether the installing of a new boiler, the purchase of a larger engine, or the use of a condenser will prove most economical. 2500 w. Engr, U. S. A. —Sept. 15, 1899. No. 29675.

Power Gas.

See Gas Engineering.

Punching.

Power Required for Punching. A reply from Wm. Sellers & Co. to an inquiry for rules or data covering the force and power required for punching iron or steel plates. 600 w. Am Mach—Sept. 21, 1899. No. 29757.

Ropes and Belts.

Transmission of Power by Means of Ropes and Belts. G. H. Thurston. Abstract of paper read before the Mech. Engs.' Assn., Johannesburg. A report of the writer's experience. 2700 w. Ir & Coal Trds Rev—Sept. 1, 1899. No. 29600 A.

STEAM ENGINEERING.

Boilers.

Cleaning Boilers. Suggests means of preventing the formation of scale. 2000 w. Engr, U. S. A.—Sept. 1, 1899. No. 29490.

Boiler Selection.

The Selection of a Boiler. Notes from a memorandum prepared by Charles E. Stromeyer, as to what are the most general demands on a boiler and what boilers are best suited for these purposes. 1200 w. Col Guard—Sept. 1, 1899. No. 29581 A.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. Discussion of paper by John W. Hill. 3000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29911 E.

Corliss Engine.

Overhauling a Corliss Engine. Charles J. Mason. On the details of practical methods of successfully operating a tandem-compound Corliss condensing engine. Ill. 7000 w. Mod Mach—Sept., 1899. No. 29427.

Dust Fuel.

The Freitag Coal-Dust Firing System (Die Freitagsche Kohlenstaubfeuerung). L. Kauffmann. An illustrated description of an improved system of automatic stoking with finely pulverized coal, as used in sugar refineries at Amsterdam. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 1899. No. 29801 D.

Fuel.

Mr. George Bielby on the Fuel of the Future. Extract from the presidential address before the Soc. of Chem. Ind. Examines the fuel problem in its relation to the smoke question, showing its magnitude and the need of the co-operation of all departments concerned. Ill. 8500 w. Gas Wld—Sept. 9, 1899. No. 29681 A.

Guarantees.

Engine Guaranties. Editorial on the worthlessness of the guarantees usually given. 1700 w. Engr, Lond—Sept. 8, 1899. No. 29702 A.

Reducer.

Pressure Reducing Devices (Druckverminderer). Hr. Randel. With illustrations and descriptions of a variety of reducing valves, and a discussion of the principles on which their action depends. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1899. No. 29803 D.

Rotary Engines.

Improvements in Rotary Engines. Illustrated description of an improved engine designed by T. M. Colwell. 1700 w. Sci Am—Sept. 16, 1899. No. 29608.

Sawmill Engines.

Steam Engines and Boilers for Sawmills. J. L. Crathorne. Describes briefly the most suitable types. 2400 w. Builder —Sept. 16, 1899. No. 29795 A.

Smoke Preventer.

Rossell's Patent Smoke Preventer. Illustrates and describes an apparatus for securing perfect combustion and thus overcoming the smoke nuisance. 1400 w. Prac Engr—Aug. 25, 1899. No. 29431 A.

Smokeless Firing with Bituminous Coal on Passenger Locomotives. A copy of the instructions issued to engine men and firemen on the Cincinnati, New Orleans & Texas Pacific Ry. and accounts of other efforts being made to avoid smoke. 1000 w. Eng News—Aug. 31, 1899. No. 29412.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. A letter from J. Morrow calls out the discussion given. 3500 w. Engr, Lond—Sept. 1, 1899. No. 29585 A.

Valve Gear.

Electrically Operated Valve Gear—Is it a Simplification or a Complication? Robert A. Bruce. Discusses the effort being made to replace the Corliss valve gear by electrically operated valves, and thinks it doubtful whether economy or convenience can be secured in this way. 1600 w. Am Mach—Aug. 31, 1899. No. 29403.

Vertical Engine.

Vertical Steam Engine of 3000 Horse Power (3000-pferdigen Vertikalen Ventildampf-machine). An illustrated description of the triple-expansion Sulzer engine built for the Luisenstrasse electric station at Berlin. Three articles. 2 plates. 3000 w. Schweizerische Bauzeitung—Aug. 12, 19, 26, 1899. No. 29836 each B.

MISCELLANY.

Address.

British Association: Mechanical Science Section. William White. Review of progress made in steam navigation; the causes of advance in speed of steamships, and length of voyages; also considers the prospects for further advance. 11000 w. Engr, Lond—Sept. 15, 1899. No. 29785 A.

American Machinery.

American Machinery in the United Kingdom. Interesting information from a British engineer concerning the amount of American machinery used and its value, the conditions of labor in the United Kingdom and related matter. 2500 w. U. S. Cons Repts, No. 535—Sept. 22, 1899. No. 29752 D.

Evaporator.

The Lillie Evaporator. Illustrated description. 900 w. Engng—Sept. 15, 1899. No. 29700 A.

Liquid Air.

Concerning Liquid Air Companies. Editorial on the number of companies and their claims, promises and offers of stock, with cautions to investors. 2000 w. Eng News—Sept. 14, 1899. No. 29619.

Liquid Air as an Explosive. Frederick H. M'Gahie. Some points of interest in regard to a trial in progress in Europe, in which liquid air is being used at one end of a tunnel being put through the Alps, and the usual explosives at the other end. 1000 w. Sci Am—Sept. 16, 1899. No. 29607.

Object Lessons.

The Lens and Pencil in Mechanical Engineering. A. B. Willits. Discusses the advantage of graphically representing details in machinery, the use of curves and sketches, the use of photographs, etc. Ill. 2500 w. Jour Am Soc of Nav Engs—Aug., 1899. No. 29396 H.

Patents.

The German Patent Law and the German Patent No. 80974 (Das Deutsche Patentgesetz und das Deutsche Reichspatent Nr. 80974). Hr. Lüders. A discussion of the suit for the annulment of the Schlick patent for balancing steam engines, including a review of the policy of the German courts in such cases. Two articles. 18000 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 26, 1899. No. 29802 each D.

Research.

The Field of Experimental Research. Elihu Thomson. Vice-Presidential address delivered at the Columbus meeting of the Am. Assn. for the Adv. of Science. On the limitations which past discoveries place upon experimental inquiry, giving experimental suggestions. 5500 w. Elec Wld & Engr—Sept. 9, 1899. No. 29532.

Trade Schools.

Mechanics, their Relation to Each Other and to Mechanical Industries—Trade Schools. John E. Sweet. Excerpts from an address delivered at Rochester, N. Y. On the apprenticeship feature of the mechanical industries, and trade schools. 3700 w. Am Mach—Sept. 7, 1899. No. 29512.

MINING AND METALLURGY

COAL AND COKE.

Coal Handling.

See Mechanical Engineering, Transmission.

Coal-Mines.

Improvements of the Spring Valley Coal Mines. J. A. Ede. A fire having destroyed the shaft of their mines and set fire to the mines, it became necessary to sink a new shaft. The conditions are explained and the improvements described and illustrated. 5700 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29707 D.

Coal Tests.

See Mechanical Engineering, Steam Engineering.

Explosions.

Gas Enclosed in Coal and Its Effect on Coal-Dust Explosions. Dr. Broockmann, in *Glückauf*. What the gases are and the amount of them in various coals. 4000 w. Mines & Min—Sept., 1899. No. 29464 C.

Invoices.

Colliery Invoices and the Purchase of Colliery Stores and Materials. George Johnson. On the outward and inward invoices of colliery companies, showing the position of storekeeper to be one of responsibility and importance. 2700 w. Col Guard—Sept. 1, 1899. No. 29578 A.

Lignite.

The Lignite Deposits in the Cologne District (Das Braunkohlenvorkommen in der Kölner Bucht). H. Dobbelstein. A very complete description of these extensive workings, with map and several sections. 4500 w. 2 plates. Glückauf—Sept. 9, 1899. No. 29868 B.

Michigan.

Coal Mining in Michigan. Charles Holmes. Describes the quality of the coal and the extent of the coal field as shown by exploration and development, and gives a brief description of the mines which have been opened and some of the causes of their successes and failures. 5800 w. Mines & Min—Sept., 1899. No. 29461 C.

Mineral Fuels.

Fuel Examination by X-Rays. M. Couriot. Gives the principles of this method for determining the impurities in mineral fuels, describing the apparatus and manner of preparing the samples, giving illustrations showing the results from various fuels. 3000 w. Mines & Min—Sept., 1899. No. 29458 C.

New Brunswick.

The Coal Deposits of the Province of New Brunswick. Describes the Grand Lake coal mines mainly. 1400. Ir & Coal Trds Rev—Sept. 15, 1899. No. 29780 A.

North Staffordshire.

The Re-Survey of the North Staffordshire Coalfield. Concerning the progress made, and information gained. 4500 w. Col Guard—Sept. 1, 1899. No. 29579 A.

Semet-Solvay.

The Manufacture of Coke by the Semet-Solvay Process. A consideration of this process, the extent to which it is used, the results of working, etc. Ill. 2200 w. Col Guard—Sept. 15, 1899. No. 29772 A.

COPPER.

Copper Alloy.

A New Hot Malleable Alloy of Copper. From a specification for an alloy of copper which may be rolled or otherwise worked at a red heat and have the necessary degree of hardness for general use. The invention of Johannes Catharinus Bull, a Swede, living in London. 450 w. Am Mach—Sept. 21, 1899. No. 29756.

The Strength of Copper and Copper Alloys at High Temperatures. Extracts from an article by George Charpy describing tests made. 900 w. Prac Engr—Sept. 15, 1899. No. 29770 A.

Copper-Deposits.

The Copper-Deposits of Vancouver Island. William M. Brewer. Gives information gained by the writer while examining and developing some of these prospects. 1800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29711 D.

GOLD AND SILVER.

Arrastra.

The Arrastra. Arthur Lakes. Illustrates and describes an ancient and effective device for treating ores, which can be cheaply constructed in inaccessible regions. 1200 w. Mines & Min—Sept., 1899. No. 29462 C.

Chile.

The Mines and Mill of the Atacama Mineral Company, Ltd., Taltal, Chile. Sidney H. Loram. An account of the work carried on by this company. Ill. 4800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29720 D.

Cyanide.

The Chemistry of the Cyanide Process. J. Ohly. Considers mainly the effect of copper and its ores and the cause and mode of determining its presence. 1500 w. Min Rept—Sept. 21, 1899. Serial. 1st part. No. 29798.

Gold Fields.

Snake River Gold Fields of Idaho. Don Maguire. Describes the river and its tributaries, discusses the sources of the very fine gold and the methods of obtaining it. 4000 w. Mines & Min—Sept., 1899. No. 29460 C.

Gold Mine.

Topeka Gold Mine at Central City, Colorado. Arthur Lakes. A description of the peculiar formation of the veins found there. Ill. 3000 w. Mines & Min—Sept., 1899. No. 29463 C.

Mexico.

The Cebollitas Camp, Chihuahua, Mexico. Describes the mines of this camp, so rich in mineral wealth and so perfect in climate that work can be carried on all the year. 900 w. Eng & Min Jour—Sept. 23, 1899. No. 29759.

The Santa Elena Mine, Mexico. Illustrates and describes this mine, the development work, surface equipment, cyanide plant, etc. 1200 w. Eng & Min Jour—Sept. 2, 1899. No. 29415.

Ore-Deposits.

The Peculiar Ore-Deposit of the East Murchison United Gold Mine, Western Australia. D. P. Mitchell. Describes and illustrates the structural features, mineralization and development. 900 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29716 D.

Production.

The Gold Production of the World. Statistics for the year 1898, showing a further increase over the high point attained the previous year. 1200 w. Eng & Min Jour—Sept. 2, 1899. No. 29414.

Prospecting.

Value of the Diamond Drill for Prospecting. H. M. Lane. On the amount of dependence which can be placed upon the record furnished by it. Ill. 1900 w. Mines & Min—Sept., 1899. No. 29457 C.

Slimes.

A Continuous Process of Slimes Treatment. A contribution to the discussion of paper by Ernest T. Rand. 1200 w. Jour of Chem & Met Soc of S Africa—July, 1899. No. 29452 E.

Smelting.

Notes on Silver Losses in Smelting. Malvern W. Iles. Discusses the conditions and causes. 4000 w. Eng & Min Jour—Sept. 9, 1899. Serial. 1st part. No. 29535.

South Africa.

Some Notes on the Mining Practice of the Witwatersrand Goldfields, South African Republic. G. A. Denny. Describes the general features of the deposits, the mining methods, etc. 5500 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29522 D.

The President's (Mr. John R. Williams) Inaugural Address. Reviews the work of the past few years in the recovery of gold, and the improvements made. 2200 w. Jour of Chem & Met Soc of S Africa—July, 1899. No. 29451 E.

Tellurium.

Tellurium and Tellurides. Describes the character of these ores and the importance of their occurrence, in connection with a recent discovery in South Australia. 2000 w. Aust Min Stand—July 27, 1899. No. 29625 B.

Transvaal.

Mining on the Witwatersrand to 12,000 ft. Deep. John Yates. Abstract of a paper recently read before the S. African Assn. of Engs., with editorial. Considers the question of working the banket beds at deeper levels than have been yet attempted. 5000 w. Eng & Min Jour—Sept. 16, 1899. No. 29658.

IRON AND STEEL.

America.

American Iron Developments. A review of existing conditions and recent changes in the iron industry of America. 2000 w. Engr, Lond—Sept. 1, 1899. No. 29587 A.

Bertrand-Thiel.

An Explanation of the Rapidity of the Bertrand-Thiel Process. Henry M. Howe. An explanation of the changes made in the various steps of the process is given. 1600 w. Eng & Min Jour—Sept. 2, 1899. No. 29416.

Blast Furnace.

Blast Furnace and Cupola Practice. Edgar S. Cook. Paper read before the Philadelphia Foundrymen's Assn. Discusses the use of casting machines for foundry iron, the improvements in blast furnace practice, the points of resemblance between blast furnace and cupola practice, etc. 3400 w. Foundry—Sept., 1899. Serial. 1st part. No. 29767.

The Relative Desulphurizing Effect of Lime and Magnesia in the Iron Blast-Furnace. O. R. Foster. Describes laboratory experiments carried out in the metallurgical laboratory of Columbia University, New York, to determine the desulphurizing action of lime-magnesia silicates when fused together with sulphurous cast-iron. 1800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29-715 D.

Canada.

Canadian Mining Project. An account of what it is expected will prove one of the largest iron and steel enterprises in the world. 900 w. U. S. Cons Repts, No. 538—Sept. 26, 1899. No. 29908 D.

Carburized Iron.

The Present Position of the Solution Theory of Carburized Iron. A. Stansfield. Read before the British Iron and Steel Inst. An explanation of the main features of this theory and its relation to the allotropic changes. 3800 w. Ir & St Trds Jour—Sept. 9, 1899. No. 29738 A.

Casting Machine.

A New Casting Machine for Blast Furnaces. Richard Hanbury Wainford. Read at the Manchester meeting of the Iron and Steel Inst. In regard to a new mechanical apparatus for casting sandless pig iron in insulated moulds, so as to maintain a good crystalline fracture, at a reduced cost. Ill. 1400 w. Engng—Aug. 25, 1899. No. 29445 A.

Coke Oven.

The Bauer By-Product Coke Oven. Illustrated description of ovens claiming the advantages of surplus of gas unconsumed, smaller space, low working expenses, and absence of smoke. 1400 w. Eng & Min Jour—Sept. 9, 1899. No. 29536.

Diffusion.

The Diffusion of Elements in Iron. John Oliver Arnold and Andrew McWilliam. Read at London meeting of the Iron and Steel Inst. Gives important facts and describes experimental methods which brought out the results presented. Ill. 3500 w. Engng—Aug. 25, 1899. Serial. 1st part. No. 29446 A.

Great Britain.

The Iron Trade Situation in Great Britain. J. S. Jeans. Comments on the statistics of the British Iron Trade Assn., for the first six months of 1899. 1700 w. Ir Age—Sept. 21, 1899. No. 29725.

Iron Industry.

The Outlook in the American Iron Industry. Archer Brown. A definite, com-

prehensive summary of the conditions and influences producing the recent extraordinary advance affecting the present situation, and determining the future course of production and prices. Reviews authoritatively the export movement and its future. 4500 w. Engineering Magazine—Oct., 1899. No. 29886 B.

Lake Superior.

The Lake Superior Iron Ore Mines and Their Influence Upon the Production of Iron and Steel. J. Head and A. P. Head. Read before the Inst. of Civ. Engs. (British). The writers visited this district to satisfy themselves concerning the competition to be expected, and to investigate the mines, ores, means of mining, loading and unloading and transporting. Part first describes the region, its topography and geology, the mining methods, mines, etc. Ill. 4400 w. Col. Guard—Sept. 8, 1899. Serial. 1st part. No. 29692 A.

Magnetic Iron.

Cape Breton Island and Its Magnetic Iron Deposit. Martin A. Macpherson. Brief account of the island and its immense wealth, the ore deposits, quantity, smelting, etc. 2200 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29449 A.

Magnetites.

A Brief Review of the Titaniferous Magnetites. J. F. Kemp. Reviews and summarizes what is known of the occurrences of the titaniferous magnetites in different parts of the world, giving a series of analyses illustrating the ranges in composition. 8500 w. Sch of Mines Quar—July, 1899. Serial. 1st part. No. 29519 D.

Manganese.

The Rar-el-Maden Mine of Manganiferous Iron (La Mine de Fer Manganésifère de Rar-el-Maden). E. Dietz. An account of the mine near Oran, Algiers, from which a valuable spiegeleisen ore is obtained. 2000 w. Rev Univ des Mines—Aug., 1899. No. 29843 G.

Pig-iron.

The Make and Stocks of Pig-iron in the First Half of 1899. Statistics concerning the production of pig-iron, and pig-iron stocks, with a statement of the condition of the furnaces in the United Kingdom. 1000 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29688 A.

Rod Rolling.

Notes on Rod Rolling and Its Development. N. K. Turnbull. Read before the West of Scotland Iron and Steel Inst. Considers chiefly the rolling of rods under ½ in. in diameter. Reviews the progress in this branch of rolling-mill work, the systems used and improvements made. 5500 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29448 A.

Statistics.

The Iron and Steel Industries of the World. From the summary prepared by James M. Swank for the United States Geological Survey. 4000 w. Col Guard—Aug. 25, 1899. No. 29441 A.

The World's Iron Output. J. Stephen Jeans. A short account of the iron-trade situation in Europe, and the bright outlook for the southern states in America. 2000 w. Am Mfr & Ir Wld—Sept. 7, 1899. No. 29534.

Steel.

The Make of Open-hearth and Bessemer Steel in the United Kingdom in the First Half of 1899. Statistics collected by the British Iron Trade Assn. 800 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29689 A.

Steel Plates.

Some Results of Transverse and Tension Tests of Steel Plates. Abstract of report given by W. K. Hatt at meeting of the Am. Sec. of the International Assn. for Testing Materials. Interesting and valuable information. 1200 w. R R Gaz—Sept. 8, 1899. No. 29565.

Tinplates.

The Manufacture of Tinplates—Past and Present. W. C. Cronemeyer. Describes the work and processes used. 3500 w. Ir & Coal Trds Rev—Aug. 25, 1899. No. 29450 A.

MINING.

Accidents.

Mining Employment and Accidents in 1898. From the report of the British Home Office on mines and quarries. Summary of information on employment in mines and quarries, and accidents of the year. 2500 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29690 A.

Air Currents.

The Control of Air Currents in Gaseous Mines. Considers the mode of treatment necessary, stating conditions often found and the remedies. 900 w. Am Gas Lgt Jour—Sept. 18, 1899. No. 29672.

Balance Sheets.

The Balance Sheet of a Mining and Manufacturing Company. George Johnson. Describes in some detail the various assets and liabilities of the balance-sheet. 3800 w. Ir & Coal Trds Rev—Sept. 1, 1899. Serial. 1st part. No. 29599 A.

Cages.

Sliding Doors for Mine Cages. From *Zeitschrift für Berg, Hutten-und Salinenwesen.* Illustrated description. 750 w. Col Guard—Sept. 15, 1899. No. 29775 A.

Drill-Holes.

Determining the Deflection of Drill Holes. G. C. McFarlane. Illustrates a device which will determine the amount and direction of a drill hole's deflection at any point, which the writer believes to be more accurate than the methods in use. 500 w. Eng & Min Jour—Sept. 16, 1899. No. 29659.

Explosives.

The Development of the Manufacture of Explosives in Austro-Hungary (Die Entwicklung der Sprengmittel-Industrie in Oesterreich-Ungarn). F. Hess. With much interesting information about the properties and composition of mining explosives. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1899. No. 29813 B.

Fans.

Note as to the Theory of Fans. S. Hanappe. From a communication to the Société des Ingénieurs des Mines du Hainaut. Mathematical demonstrations showing the applicability of Bernouilli's theorem to the motion of air between fan vanes. 1500 w. Col Guard—Sept. 15, 1899. No. 29778 A.

Gas.

Outbursts of Gas at Lancashire Collieries. John Gerrard. Communication to the Geological Society. Describes the outburst in the Westleigh colliery in December last, and also an outburst in the Arley Mine, Welch Whittle, in 1897. 1300 w. Col Guard—Sept. 15, 1899. No. 29774 A.

Hoisting Engine.

The Tamarack Mining Company's New Hoisting Engine. An illustrated detailed description, with editorial on hoisting engine development. 2500 w. Am Mach—Sept. 7, 1899. No. 29511.

Inspection.

The Periodical Inspection of Mines by Workmen. Extracts from a summary of the Prussian Government Commission, which visited, England, Belgium and France to obtain information as to the working of this system. 1400 w. Col Guard—Sept. 8, 1899. No. 29694 A.

Lamps.

The Safety of the Electric Miners' Lamp as Compared with the Ordinary Miners' Lamp. Sydney F. Walker. Maintains that the general adoption of electric portable lamps would lead to decreased accidents and lower working costs. 2200 w. Col Guard—Sept. 15, 1899. No. 29773 A.

Madagascar.

Mining in Madagascar. From the report of F. W. Turner. Iron, copper, silver, and lead have been discovered, and also tin. Gives some points on French mining laws. 900 w. Engr, Lond—Sept. 8, 1899. No. 29700 A.

Mining Law.

Arbitration Clauses in Mining Leases. Adjudications and essential facts relating to decisions pronounced in the Supreme and Appeal Courts of England, and in the Court of Session of Scotland. 3000 w. Col Guard—Sept. 1, 1899. No. 29576 A.

Mining Machinery.

Abuse of Mining Machinery. D. L. Howard. Read before the Ohio Inst. of Min. Engs. Calls attention to a few of the abuses and injuries and the disadvantages under which the machinery is worked. 1300 w. Can Min Rev—Aug. 31, 1899. No. 29428 B.

Machine Coal-Cutting in 1898. Edward W. Parker. Postscript to a paper on "Coal-Cutting Machinery," presented at the New York meeting. 1000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29714 D.

Recent Silesian Mining Machinery (Neuere Bergwerksmaschinen Schlesischer Werke). H. Dubbel. Especially describing and illustrating some large underground pumping engines of recent design, with details of the valves, and indicator cards from the steam and water cylinders. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29808 D.

The Lee Long-Wall Mining Machine. H. Foster Bain. A description of this machine, which is simple in operation and applicable to a wide range of long-wall work. Ill. 2500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29719 D.

Mining Plant.

The Surface Plant of the French Rand Gold Mining Co. (Installation de Surface des Mines d'Or de la French Rand Gold Mining Co.). J. Dupont. A general account of the stamp mills, cyanide plant, and other surface works of the French Rand Co., at Johannsburg. 2500 w. 1 plate. Génie Civil—Aug. 26, 1899. No. 29823 D.

See Electrical Engineering, Distribution.

Primitive Mining.

Primitive Mining in Staffordshire. A brief account of the early mining in this district. 900 w. Col Guard—Sept. 1, 1899. No. 29582 A.

Pump.

The Kaselowsky Drainage Pump (La Machine d'Epuisement Système Kaselowsky). C. François. Describing a subterranean pump operated by hydraulic pressure and used for mine drainage. 3000 w. 2 plates. Rev Univ des Mines—Aug., 1899. No. 29842 G.

Pumping.

Pumping Difficulties in the Maypole Colliery Sinking. J. Keen. Abstract of paper read before the Manchester Geol. Soc. Describes difficult work and the appliances used. Ill. 3700 w. Ir & Coal Trds Rev—Sept. 15, 1899. No. 29779 A.

Rescue Appliances.

Apparatus for Re-charging Rescue Appliances with Oxygen. J. Mayer, in *Oesterreichische Zeitschrift für Berg und Huttenwesen.* Illustrates and describes an apparatus for re-charging the oxygen bottles by compressing the oxygen, so as to obtain the gas under maximum pressure even when the cylinder pressure has diminished. 1000 w. Col Guard—Sept. 1, 1899. No. 29580 A.

The Charging of Oxygen Cylinders for Life-Saving Apparatus (Vorrichtungen zum Nachfüllen der Sauerstoff-Flaschen bei den Rettungsapparaten). Joh. Mayer. Describing methods of charging the oxygen reservoirs of portable devices for use in gaseous mines. Two articles. 4000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 19, 26, 1899. No. 29867 each B.

Safety.

Safety Appliances for Hoisting Machines (Sicherheitsvorrichtung für Fördermaschinen). C. Budil. A description of the Wodrada apparatus, recently installed in Moravia, by which any excess in speed of the cage gives an alarm in the engine room. 1000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29809 D.

Schools.

Correspondence Schools. R. P. Rothwell. Discussion of this paper. H. H. Stock's reply to Mr. Rothwell's criticisms. 2000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29717 D.

Shafts.

Automatic Shaft-Closing Arrangement at a Westphalian Colliery. From *Glückauf.* Illustrates a simple and original design which has proved satisfactory. 400 w. Col Guard—Sept. 1, 1899. No. 29577 A.

Sinking a Shaft with Means for Taking Off the Water. From *Glückauf.* Illustrates and describes the Tomson water-raising arrangement. 800 w. Col Guard—Sept. 15, 1899. No. 29776 A.

Surveying.

The Evolution of Mine-Surveying Instruments. Discussion of this paper by Dunbar D. Scott. Ill. 7300 w. Trans Am Inst of Min Engs—Oct., 1898. No. 29721 D.

Timbering.

Systematic Timbering in Mines. Discussion of a movement in England to insist on the systematic timbering of mines, showing that such an order would only increase expense and tend to diminish the safety. 800 w. Col Guard—Sept. 8, 1899. No. 29693 A.

Tubbing.

Repairs to a Shaft Tubbing at a Westphalian Colliery. From a communication by Ingenieur Schulte to *Glückauf.* Longitudinal and transverse sections showing the method by which the water inburst was eventually kept back and the shaft made tight. 1600 w. Col Guard—Aug. 25, 1899. No. 29440 A.

Ventilation.

Influence of Natural Ventilation in Mines Ventilated Artificially. A discussion of the effect, which either adds to the force or is antagonistic, and the necessary allowance to be made. 900 w. Col Guard—Sept. 15, 1899. No. 29777 A.

Water Power.

The Utilization of Drainage Water to Work a Turbine Driving a Winch. An illustrated account of a turbine installation in a French colliery. 800 w. Ir & Coal Trds Rev—Sept. 8, 1899. No. 29691 A.

Workings.

Cooling Down Warm Working Places Under Ground. Bergassessor Tübben, in *Glückauf.* Proposes a method of cooling down by means of liquid air. 1400 w. Col Guard—Sept. 1, 1899. No. 29584 A.

MISCELLANY.

Amalgamation.

Note on Plate-Amalgamation. Allan J. Clark. Gives results of experiments made on the large plate-surface in the mills of the Homestead Company, to determine whether silver gave evidence of a tendency to escape amalgamation. 700 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29712 D.

Calciner.

The Latest Type of Mechanical Calciner. W. Blackmore. Read before the Institution of Mining and Metallurgy. Describes the Godfrey Mechanical Calciner, designed to calcine zinc and leady-zinc ores. 1900 w. Ir & St Trds Jour—Sept. 9, 1899. No. 29737 A.

Diamonds.

The Occurrence of Diamonds in New South Wales. A report by D. C. McLachlan, Under-Secretary for Mines and Agriculture, Sydney, N. S. W. Thinks the diamond-mining industry destined to become important in these areas. 1400 w. Jour Soc of Arts—Sept. 8, 1899. No. 29676 A.

Laboratories.

The Equipment of Metallurgical La-

boratories. Henry M. Howe. Discusses mainly the value of laboratory work for undergraduate students, but thinks it of great benefit to advanced students and all who wish to investigate metallurgical problems. 3000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29710 D.

Metallurgy.

Metallurgical Processes (Metallhüttenwesen). C. Schnabel. The first of a series of metallurgical articles; this installment is devoted to roasting furnaces for copper ores. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1899. No. 29810 D.

Metallography.

See Mechanical Engineering, Materials.

Mexico.

Notes on the Geology of Sonora, Mexico. E. T. Dumble. Gives results of geological investigations. 11800 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29722 D.

Mica.

Occurrence of Mica in South Norway. J. F. Wells. Condensed from a paper before the Inst. of Min. and Met. Describes a mica mine in Norway, showing remarkably coarse crystallization of some of the minerals. 1300 w. Min & Sci Pr—Aug. 26, 1899. No. 29397.

Minerals.

Minerals of the Southern States. From an account prepared by the Southern Railway of the United States. Facts and figures concerning coal, iron, manganese, corundum, copper, bauxite and aluminum ore. 4200 w. Ind & Ir—Aug. 25, 1899. No. 29433 A

Ores.

On the Separation and Determination of Arsenic and Antimony in Ores. O. C. Beck and H. Fisher. Compares the different known methods in order to determine which is the shortest and most accurate. 2200 w. Sch of Mines Quar—July, 1899. No. 29521 D.

Rock-Salt.

Rock-Salt in Louisiana. A. F. Lucas. An account of localities known, with particulars concerning the development of the deposits, giving illustrations and details not heretofore published. 4200 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29709 D.

Rocky Mountains.

Notes on the Structure of the Rocky Mountains in the Lewis and Clarke Timber Reserve, Montana. Robert H. Chapman. Description with map. 1300 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29713 D.

Smelting.

A Furnace for Smelting Zincy Lead Ores. Ludwig Kloz. Drawings and description of a furnace designed to meet special conditions. 800 w. Eng & Min Jour—Sept. 2, 1899. No. 29417.

Tin Field.

Herberton Tin Field (Q.). Arthur Babington. Information concerning these deposits in North Queensland, and their workings. 2200 w. Aust Min Stand—Aug. 3, 1899. Serial. 1st part. No. 29626 B.

Tin-Ore.

The Occurrence of Tin-Ore at Sain Alto, Zacatecas, with Reference to Similar Deposits in San Luis Potosi and Durango, Mexico. Edward Halse. Describes the various workings and compares them with deposits named. Ill. 2400 w. Trans Am Inst of Min Engs—Sept., 1899. No. 29718 D.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Detailed list and classified summary. 4500 w. R R Gaz—Sept. 22, 1899. No. 29746.

Railroad History.

The Pennsylvania Railroad Fifty Years Ago. Facts concerning the first scheduled train, and the building of this road. 600 w. R R Gaz—Sept. 15, 1899. No. 29666.

LEGAL.

Texas Law.

Judicial Construction of the Texas Anti-Rebate Law. Gives the construction of Judge Howard Templeton of the District Court at Sulphur Springs. 1600 w. Ry Age—Sept. 8, 1899. No. 29538.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Westinghouse Air Brakes on Russian Railways. Translation of the ministerial order requiring all standard Russian railways to equip their freight cars and engines with the Westinghouse air brakes by Jan. 1, 1903. 2200 w. U. S. Cons Repts, No. 531—Sept. 18, 1899. No. 29673 D.

Automotor Cars.

Automotor Cars for Railways. De-

scribes and illustrates the "hydro-carbon" car tried at Columbus, Ind., and gives schemes for the transformation of Italian railways. 1500 w. Transport—Aug. 25, 1899. No. 29455 A.

Axles.

See Mechanical Engineering, Machine Works.

Chapel Cars.

Chapel Cars on Railroads. Rev. C. H. Rust. Illustrates and describes these cars and the work which they do. 1000 w. Ry & Engng Rev—Sept. 16, 1899. No. 29670.

Dining Cars.

Modern Dining Cars for the Southern Railway. Plan and interior views, with description of carefully arranged and handsome cars. 700 w. Ry & Engng Rev—Sept. 9, 1899. No. 29548.

New B. & O. Dining Cars. Plan and views, with brief description. 200 w. R R Gaz—Sept. 8, 1899. No. 29563.

Draft Rigging.

The Dayton Draft Rigging. Illustrates and describes three applications of a new draft rigging designed by Edward Grafstrom. 700 w. R R Gaz—Sept. 1, 1899. No. 29406.

Hot Bearings.

The Use of Water on Hot Bearings of Engines and Tenders. Extracts from the committee report presented by Charles A. Crane to the Traveling Engs. Assn. Gives replies to circular letter of inquiry. Information favors the use of water. 1100 w. Ry & Engng Rev—Sept. 16, 1899. No. 29668.

Locomotive Erection.

Rapid Locomotive Erection in France. Illustrations and information on the quick erection of a locomotive in one of the shops of the Eastern of France Railway. 900 w. Engng—Sept. 1, 1899. No. 29597 A.

Locomotives.

A New Lackawanna Locomotive. Engraving and dimensions of a new locomotive recently built at the Scranton shops of the Delaware, Lackawanna & Western Railroad. 350 w. Ry Age—Sept. 8, 1899. No. 29539.

Cooke Ten-Wheel Freight Locomotive, Oregon Short Line. Half-tone view and description. 900 w. Ry & Engng Rev—Sept. 2, 1899. No. 29492.

Locomotives Built at the Old Haigh Foundry. Clement E. Stretton. An account of engines built from 1835 to 1856. 1800 w. Mech Wld—Sept. 15, 1899. No. 29792 A.

New Atlantic Type Locomotives on the Canadian Pacific. Engraving, description and a brief of the specifications. 600 w. R R Gaz—Sept. 15, 1899. No. 29665.

Pennsylvania Class F 1-A Freight Locomotives. Illustration and brief description. 250 w. R R Gaz—Sept. 22, 1899. No. 29744.

Pneumatic Locomotives. A. E. Kyffin. Explains the main features of pneumatic locomotives and their working, the cost, and advantages. 1900 w. Prac Engr—Sept. 15, 1899. No. 29771 A.

The Illinois Central's New Locomotive. Illustrated description of a 12-wheeled consolidation engine that up to date is the largest and heaviest locomotive in the United States. 900 w. Ry Age—Sept. 22, 1899. No. 29768.

United States Competition in the Locomotive Export Trade. Part first discusses locomotive building, giving extracts from a recent article in the *Engineering News*, with comments. 3000 w. Engr, Lond—Sept. 15, 1899. Serial. 1st part. No. 29781 A.

Locomotive Tests.

Tests of English Express Locomotives. Discusses points brought out by a series of trials of different types of express locomotives. Also editorial on train resistance, lessons drawn from the results given. 2700 w. R R Gaz—Sept. 15, 1899. No. 29663.

Rolling Stock.

The Rolling Stock of the Great Central Railway. Illustrates and describes details in the design of new cars. 2200 w. Engng—Aug. 25, 1899. No. 29442 A.

Springs.

Locomotive Driving Springs. Editorial discussion of the proper methods of shop treatment. 900 w. Ry & Engng Rev—Sept. 16, 1899. No. 29671.

Ventilation.

A Plan for the Ventilation of Railway Carriages (Ein Vorschlag zur Ventilation Fahrender Eisenbahnwaggons). Dr. A. Hinterberger. A description of a method by which air is forced through a small pipe and delivered into the compartments of each carriage through a number of perforations. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1899. No. 29812 B.

NEW PROJECTS.

Africa.

Cape Railways. A review of the year ending Dec. 31, 1898, as given in the annual report. 700 w. Engr, Lond—Aug. 25, 1899. No. 29436 A.

China.

An All-British Railway to China. C. A. Moreing. Notes some of the changes the Siberian Railway will effect, and considers the advisability of Great Britain carrying a continuous line from the Mediterranean to the Yang-tze. 3800 w. Nineteenth Cent—Sept., 1899. No. 29631 D.

Notes from Newchwang. J. Grant Birch. Deals with the Eastern Chinese railway and other engineering works. Ill. 2500 w. Engng—Sept. 15, 1899. No. 29789 A.

Honduras.

Proposed Railroad in British Honduras. A proposal of British capitalists for the construction and working of a railway from Belize to Guatemala. 1000 w. U. S. Cons Repts, No. 529—Sept. 15, 1899. No. 29630 D.

Jungfrau.

The Jungfrau Railway. Gives a description of the line so far as it is built, its operation and equipment. 3800 w. Engng—Sept. 8, 1899. No. 29706 A.

Manchuria.

The Manchurian Railway. Editorial comment on the Russian Imperial order declaring Talienwan a free port. 1200 w. Engng—Sept. 1, 1899. No. 29594 A.

Rhodesia.

Rhodesia and Its Railways. Extracts from a pamphlet recently published by the British South African Co. On the rapid development of the last ten years, giving interesting facts relating to the railways. Ill 900 w. Transport—Sept. 8, 1899. No. 29677 A.

Siberia.

Work on Siberian Railway. Translation of an article from the *Novoe Vremia*. On changes that must be made to meet the unexpected traffic, and giving a brief description of the road. 800 w. U. S. Cons Repts, No. 524—Sept. 9, 1899. No. 29517 D.

West Africa.

The Sierra Leone Railway. An interesting account of the construction of the road, with many illustrations. 3000 w. Engr, Lond—Sept. 8, 1899. No. 29701 A.

PERMANENT WAY AND FIXTURES.

Boston Station.

Back Bay Station of the New York, New Haven & Hartford. Describes a new way-station, Italian Renaissance in architectural style. 750 w. R R Gaz—Sept. 8, 1899. No. 29564.

The New South Station of the Boston Terminal Company. H. W. Weller. History and illustrated description of this fine station, also illustrations of abandoned stations of the roads now brought into this one train-shed. 2409 w. Am Arch—Sept. 16, 1899. Serial. 1st part. No. 29660.

Bumping Posts.

Concrete Bumping Posts, C. R. I. & P. Ry. Describes and illustrates a superior post consisting of a concrete pier 10 ft. long, 4½ ft. wide, and 9 ft. deep, reaching 4 ft. below the surface. 500 w. Ry & Engng Rev—Sept. 9, 1899. No. 29547.

Car Shops.

The New Car Shops of the John Stephenson Company, Ltd. Charles Henry Davis. Historical sketch and illustrated detailed description with other information. 4500 w. Eng Rec—Sept. 23, 1899. Serial. 1st part. No. 29901.

English Railway.

The Great Central Railway from Leicester to Rugby. Illustrates and describes the Braunstone Gate bridge and other features of the permanent way. 3200 w. Engr, Lond—Sept. 1, 1899. No. 29586 A.

Frogs.

Hinged Switch and Cast Steel Frog: Netherlands State Railways. Illustrates and describes two interesting features of track construction. 500 w. Eng News—Sept. 7, 1899. No. 29555.

Improvements.

Improvements in Alignment and Grades, C. B. & Q. Ry. Illustrates and describes heavy and extensive work. 2400 w. Ry & Engng Rev—Sept. 23, 1899. No. 29906.

Oil Stations.

Oil Stations in Russia. From "Apercu des Chemins de Fer Russes." Illustrated description. 800 w. Ry Age—Sept. 1, 1899. No. 29482.

Rail Breakage.

The Breakage of Steel Rails. Editorial review and criticism of paper by W. G. Kirkaldy, published by the Inst. of Civ. Engs., England. 1800 w. Eng News—Aug. 31, 1899. No. 29410.

Rail-Sections.

Important Results Obtained in the Past Fifteen Years with the Stiff and Heavy Rail-Sections. Dr. P. H. Dudley. Discussion of this paper. Ill. 2400 w. Trans Am Inst of Min Engs—Feb., 1899. No. 29708 D.

Station Grounds.

Improvement of Station Grounds at Mechanicville, N. Y., D. & H. Ry. Illustrated description of recent improvements effected. 1000 w. Ry & Engng Rev—Sept. 9, 1899. No. 29544.

Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Discussion of paper by W. W. Curtis. 1000 w. Pro Am Soc of Civ Engs—Sept., 1899. No. 29914 E.

Track Forces.

Reorganization of the Track Forces on the Ohio River Railway. Gives particulars of a new system of dividing the labor in track maintenance, arranged to

provide a more thorough inspection of track and economy in track repairs. Also editorial. 2500 w. Ry & Engng Rev—Sept. 9, 1899. No. 29545.

Track-Laying.

Holman-Burke Track-Laying Machine on the "Soo Line." Describes and illustrates an improved machine in use on the Minneapolis, St. Paul and Sault Ste. Marie Ry. 1600 w. Ry & Engng Rev. Sept. 9, 1899. No. 29546.

Tracks.

Modern Developments in Track and Track Work. E. E. Russell Tratman. Abstract of an address delivered before the Roadmasters' Assn. of America, at Detroit. Remarks on improvements and features which depart somewhat from usual practice. 3000 w. Eng News—Sept. 21, 1899. No. 29748.

Relation of Track to Traffic. B. R. Coates. Read before the Roadmasters' Assn. of America. Discusses this subject and gives the opinion that the track conditions are not proportionate to the load and stress. 1800 w. Ry & Engng Rev—Sept. 16, 1899. No. 29669.

Steel Foundations for Steam Railroad Track. Gustav Lindenthal. Considers the substitution of metal cross ties for those of wood, and heavier and harder rails for the lighter rails in use. 3000 w. R R Gaz—Sept. 8, 1899. Serial. 1st part. No. 29562.

The Spotting and Grooving Machine—Flint & Pere Marquette Ry. Illustrated description of a device for the cutting and evening of the rail seats on the ties as they lie in the track. 1600 w. Ry & Engng Rev—Sept. 23, 1899. No. 29907.

Track Scales.

Arrangement of Track Scales—Chicago, Lake Shore & Eastern Railway. Illustrates a highly satisfactory arrangement, the distinctive feature of which is the ease of operation and the handling of the cars. 600 w. R R Gaz—Sept. 15, 1899. No. 29664.

Tunnels.

The Ventilation of Tunnels. Francis Fox. Condensed from a paper read before the Inst. of Civ. Engs., England. Describes the systems in use in various tunnels and the results. Long discussion. 7500 w. Eng News—Aug. 31, 1899. No. 29408.

The Ventilation of Tunnels (Ventilation des Tunnels). R. Godfernaux. The first paper of a series treating very thoroughly of the conditions involved in tunnel ventilation, both from a practical and theoretical standpoint. Data from numerous existing tunnels are given. Serial. Part 1. 2500 w. Génie Civil—Aug. 19, 1899. No. 29822 D.

Viaducts.

Railway Viaducts in Cornwall, Old and New. T. H. Gibbons. A general description of the old viaducts, placing them under two classes; those carried on timber trusses, supported for the most part on timber piles which form the piers; and those over valleys when good foundations are to be had. Also describes the new viaducts. Ill. 3500 w. Inst of Mech Engs—1899. No. 29724 D.

See Civil Engineering, Bridges.

TRAFFIC.

Freight Classifications.

Efforts to Unify the Freight Classifications. J. W. Midgley. On the course that should be adopted to carry the movement to successful completion. 2500 w. Ry Age—Sept. 15, 1899. No. 29667.

Grain-Rate Decision.

The Latest Grain-Rate Decision. Editorial discussion of Commissioner Prouty's opinion on export and domestic rates. 1500 w. R R Gaz—Sept. 8, 1899. No. 29568.

Statistics.

Poor's Railroad Statistics. Editorial comment on information furnished in the introduction to "Poor's Manual" for 1899. 900 w. R R Gaz—Sept. 8, 1899. No. 29567.

Tonnage.

Some Results of the Use of Tonnage Statistics. Gives a practical example of the use of ton-mile statistics as a means of economy. Documents sent to the editor by Mr. Kruittschmitt of the Southern Pacific. 3800 w. R R Gaz—Sept. 1, 1899. No. 29404.

STREET AND ELECTRIC TRAMWAYS.

Address.

President's Address to the Street Railway Association of the State of New York, at Ithaca. G. Tracy Rogers. Touching many subjects of interest, showing the great advancement of the past year in street railway development. 5500 w. St Ry Rev—Sept. 15, 1899. No. 29728 C.

Combined Operation.

Combined Operation of Trolley and Steam Systems on the Long Island Railroad. Illustrates and describes some features of the experiment in operating the Rockaway Beach division of this road. 1400 w. Elec Wld & Engr—Sept. 2, 1899. No. 29422.

Compressed Air.

Compressed Air Traction in New York City. Illustrates and describes the compressing engine, which is of interest on account of its size and power, and the high working pressure. 1800 w. Sci Am —Sept. 16, 1899. No. 29609.

Costs and Profits.

Comparative Costs and Profits of Cable, Electric and Horse Traction in New York City. Receipts and expenses of the Metropolitan Street Railway Co., of New York City, for the year ending June 30, 1899, as compared with the previous year. 1800 w. St Ry Jour—Sept., 1899. No. 29478 D.

Coventry.

Coventry Electric Tramways. Illustrated detailed description of a successful English tramway. 3500 w. Tram & Ry Wld—Sept. 7, 1899. No. 29742 A.

Electric Railways.

Revolution of the Present Railway System by the Advent of the Elevated Electric Railway. A. Davis. Discusses the steam surface railway and its progress and expense, and the elevated electric railway as an improvement, noting the road about to be built between Liverpool and Manchester, Eng. 2300 w. Can Engr—Sept., 1899. No. 29623.

Employees.

How Can We Increase the Efficiency of Employees? F. D. Rounds. Read before the N. Y. St. Ry. convention. Discusses wages, selection of applicants, education, treatment, and chances of promotion. Discussion follows. 3300 w. St Ry Rev—Sept. 15, 1899. No. 29729 C.

Gas Traction.

Gas Traction on the Blackpool, Lytham and St. Anne's Trams. W. Chew. Read before the Manchester (Eng.) District Inst. of Gas Engs. Describes the route, station and appliances and working, giving some results. 1300 w. Jour Gas Lgt—Sept. 12, 1899. No. 29741 A.

In Defence of Gas Traction and the Latest Example. Concerning the new installation at Neath, and stating some of the advantages. 1700 w. Jour Gas Lgt—Sept. 5, 1899. No. 29604 A.

Glasgow.

Engines for Glasgow Tramways. From the *Glasgow Herald*. A discussion of the facts and considerations relating to this contract, with an account of the Allis type of engine. 3300 w. Am Mfr & Ir Wld—Sept. 21, 1899. No. 29755.

Glasgow Corporation Tramways. Text of Mr. Parshall's specification in so far as it refers to the construction of the main engines, with editorial discussion of the American tenders. 6200 w. Engr, Lond—Aug. 25, 1899. No. 29438 A.

The Contract for the Engines of the Municipal Electric Railways of Glasgow, Scotland. Editorial review of the controversy in Great Britain over the recent action of the Town Council of Glasgow in connection with the bids for four 4,000-H. P. and two 800-H. P. engines. 3700 w. Eng News—Sept. 21, 1899. No. 29749.

The Glasgow Tramway Contracts. Editorial review of the trouble in connection with the contracts for the engines for the electric tramways. 2200 w. Engng—Aug. 25, 1899. No. 29444 A.

The Glasgow Tramways Contract. G. L. Addenbrooke. A letter to the editor giving a very interesting explanation of the present position of electrical engineering in Great Britain. 2300 w. Engr, Lond—Sept. 8, 1899. No. 29705 A.

Hamburg.

Electric Street Car System of Hamburg. Interesting information of the construction and management of what is claimed to be the most complete system on the Continent. 1800 w. U. S. Cons Repts. No. 518—Sept. 1, 1899. No. 29413 D.

Hartford.

"Kinks" from Hartford. Illustrates and describes recent additions to the power station and other improvements. 2400 w. St Ry Jour—Sept., 1899. No. 29477 D.

Kashmir Railway.

Kashmir Electric Railway Scheme. Concerning a project brought forward by M. Nethersole, State Engineer, for working the line by electricity, and adopting a route differing considerably from previous plans. Maps. 1300 w. Elec Rev, Lond—Sept. 8, 1899. No. 29685 A.

Marseilles.

The New Permanent Way of the Marseilles Tramways (Les Nouvelles Voies des Tramways de Marseille). A. Magnier. With sections of the rails, details of the joints and bonding, and views of the switches and curves. 2500 w. Revue Technique—Aug. 25, 1899. No. 29827 D.

Massachusetts.

A Cross Country Electric Railway in Eastern Massachusetts. An illustrated detailed account of the Norfolk Western Street Railway Company, with general introductory information. 3300 w. St Ry Jour—Sept., 1899. No. 29472 D.

Mechanical Traction.

Dr. Kennedy on Mechanical Traction for the London Tramways. Review of report of Dr. A. B. W. Kennedy furnished for the guidance of the London County Council. 2000 w. Jour Gas Lgt —Aug. 29, 1899. No. 29506 A.

Northern Ireland.

The Portrush and Giant's Causeway Electric Railway. Brief description, with illustrations of an electric railway eight miles long, the first constructed in the United Kingdom. 900 w. Engr, Lond—Sept. 8, 1899. No. 29703 A.

Paving.

The Paving Question. T. J. Nicholl. Read before the N. Y. St. Ry. convention. Considers the injustice in requiring the street railways to keep the pavement in repair. 2200 w. St Ry Rev—Sept. 15, 1899. No. 29731 C.

Power Distribution.

Railway Power Distribution Over Large Areas. A. H. Armstrong. Read before the N. Y. St. Ry. convention. Describes the system adopted by the International Traction Co. for the operation of the various roads in Buffalo and vicinity. 1800 w. St Ry Rev—Sept. 15, 1899. No. 29732 C.

Power Station.

Power Station of the Metropolitan Street Railway Company. Brief illustrated description of the Ninety-sixth station, with map showing location of this and the sub-stations. 800 w. St Ry Jour—Sept., 1899. No. 29479 D.

Rail Bonds.

Bonding Electric Rail Tracks. W. G. T. Goodman. Read at meeting of the Elec. Assn. of New South Wales. Describes the various systems of bonding, and the damage and loss incurred through defective bonding. 2300 w. Aust Min Stand—Aug. 10, 1899. Serial. 1st part. No. 29627 B.

Electric Welding. R. F. Danforth. Read before the N. Y. St. Ry. convention. Describes the process used by the Johnson Co. in welding the rails of the Buffalo Ry. Co. 2000 w. St Ry Rev—Sept. 15, 1899. No. 29730 C.

Experiments on Rail Bonds. Henry H. Norris. Read before the N. Y. St. Ry. convention. The importance of this subject is discussed, the difficulty of keeping the bonding in good condition, poor bonding, inspection, etc. 2000 w. St Ry Rev—Sept. 15, 1899. No. 29734 C.

Repairs.

Practice in the Repair Shops of the Chicago City Railway Company. Illustrates and describes a trolley-wheel turning device, a machine for splitting rattan, coil taping stands and bobins, baking coils, etc., etc. 4800 w. St Ry Jour—Sept., 1899. No. 29475 D.

Practice in the Repair Shops of the North Chicago Street Railway Company. Deals with the cutting of gears and pinions, use of copper, motor cranes, armature testing device, fenders and other safety devices. Ill. 1800 w. St Ry Jour—Sept., 1899. No. 29474 D.

Rolling Stock.

New Rolling Stock for Liverpool Tramways. Illustrates and describes the new top-seat motor cars which are being supplied. 700 w. Tram & Ry Wld—Sept. 7, 1899. No. 29743 A.

Sheffield, Eng.

Sheffield Corporation Tramways. Illustrated detailed description. 2700 w. Elect'n, Lond—Sept. 1, 1899. No. 29569 A.

Splicing Cars.

Splicing Cars in Philadelphia. Illustrates and describes the splicing of two short cars together to make a long car. 250 w. St Ry Jour—Sept., 1899. No. 29476 D.

Statistical Data.

Some Electric Street Railway Data. Harris J. Ryan. Read before the N. Y. St. Ry. convention. Average of answers to questions sent to plants in the United States concerning the construction and operation. 1500 w. St Ry Rev—Sept. 15, 1899. No. 29733 C.

Storage Battery.

The Englewood & Chicago Storage Battery Line. An account of a successful storage battery line which has been in operation more than two years. Ill. 1800 w. St Ry Jour—Sept., 1899. No. 29473 D.

Switzerland.

The Burgdorf-Thun Railway. Illustrated description of an interesting electrically-driven heavy railway, 25 miles long, with a 16,000-volt overhead transmission, and overhead distribution to the train of three-phase current at 750 volts pressure. 1400 w. Elect'n, Lond—Sept. 8, 1899. Serial. 1st part. No. 29683 A.

Trolley Wires.

The Influence of Temperature Upon the Wires of Electric Tramways (Ueber den Einfluss der Temperatur auf den Fahrdraht Elektrischer Bahnen). Dr. M. Eisig. A discussion of the stresses produced by expansion and contraction. 2000 w. Elektrotech Zeitschr—Sept. 14, 1899. No. 29862 B.

Underground Wiring.

Underground Wiring of the Toledo Traction Co. Illustrates description of the work of placing underground the lighting mains and feeder wires in the business district of this city. 1400 w. St Ry Rev—Sept. 15, 1899. No. 29735 C.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

The Shaw Electric Crane Company, Muskegon, Mich., U. S. A.—Handsomely bound catalogue of electric traveling cranes with numerous illustrations of three-motor cranes in active service.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.—Pamphlet describing Dixon's Ticonderoga flake graphite especially adapted for the lubrication of cylinders and valves. The method of using the lubricant is described and numerous testimonials are appended.

The Standard Welding Co., Cleveland, Ohio, U. S. A.—Pamphlet catalogue of seamless steel tubing and of electrically welded bicycle parts.

The J. H. McLain Co., Canton, Ohio, U. S. A.—Large and handsomely illustrated catalogue of sectional boilers for heating by steam or hot water. Tables of sizes and ratings are given, together with other useful information in connection with the warming of buildings.

The Richmond Stove Company, Norwich, Conn., U. S. A.—Catalogue of the Richmond heaters for steam or hot water, with many illustrations showing designs and parts, and with specifications of the various sizes.

Sullivan Machinery Company, Chicago, Ill., U. S. A.—Catalogue No. 30, describing the various forms of Sullivan rock drills for mining, shaft sinking, tunneling, rock excavation, and quarrying. Many illustrations of the applications of the drills are given, also descriptive specifications, and code words for machines and parts.

J. B. Colt & Co., New York.—Catalogue of acetylene gas apparatus and accessories describing the Criterion generator and giving much useful information concerning the construction and use of acetylene generators. The rules of the National Board of Underwriters concerning the installation of acetylene plants are given in full.

The Watson-Stillman Co., New York.—Special pamphlet catalogue of hydraulic jacks for every variety of service together with other auxiliaries for use in similar work. Full directions for using and caring for hydraulic jacks are given.

F. W. Emerson Manufacturing Company, Rochester, N. Y., U. S. A.—Catalogue and price list of drafting room furniture and accessories, including drawing tables, cabinets, trestles, blue print frames, and general furniture for drawing rooms.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.—Handsomely illustrated catalogue of electric mine locomotives for underground haulage, showing machines for a great variety of service as actually installed in numerous collieries. This catalogue is issued in connection with the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., the machines being the joint products of the two firms. Tables of dimensions of the locomotives are given and also the hauling capacity upon various grades.

Charter Gas Engine Co., Sterling, Ill., U. S. A.—Pamphlet describing the Charter gasoline and gas engines, showing the application both for general power purposes and for pumping. A very complete form of portable gasoline engine is illustrated.

H. L. Frost, Bristol, Tenn., U. S. A.—Pamphlet describing the pneumatic water-elevator of the publisher adapted for raising water by direct air pressure.

Dunn Manufacturing Company, Pittsburg, Pa., U. S. A. Pamphlet catalogue describing and illustrating extensible trench-braces for supporting the sides of trenches during excavation, pipe-laying, and similar work.

Fraser & Chalmers Chicago, Ill., U. S. A.—Pamphlet containing text of court decision sustaining the validity of patents on the Brown roasting furnace, of which furnace Messrs. Fraser & Chalmers are the sole manufacturers.

M. C. Bullock Mfg. Co., Chicago, Ill., U. S. A. Catalogue No. 33, relating to diamond drills, giving a great variety of illustrations of diamond drilling apparatus for deep drilling and prospecting. Many testimonials are given, and a biographical sketch and fine portrait of the late Milan C. Bullock form an introduction.

The American Well Works, Aurora, Ill., U. S. A.—Pamphlet catalogues *(a)* form 78, of pumping machinery, air water lift, and air compressors; *(b)* of well sinking machinery and gasoline engines. Both pamphlets are fully illustrated and give detailed specifications of the various machines.

The "Long-Arm" System Co., Cleveland, Ohio, U. S. A.—Pamphlet describing the "long arm" apparatus for closing bulkhead doors on vessels. Pneumatic or hydraulic pressure is used to operate sliding doors in such a manner as to render the closing of doors water-tight in case of emergency possible. Illustrations and descriptions of tests made on United States Cruiser Chicago are given.

Odorless Excavating Company, Boston, Mass., U. S. A.—Pamphlet illustrating and describing the odorless pumps and cess-pool cleaning apparatus manufactured by this company.

City-Wastes Disposal Company, New York.—Neatly printed pamphlet setting forth the methods of the company, an organization composed of the associates of the late Col. G. E. Waring, for the introduction and execution of modern sanitary methods of street-cleaning into cities and other communities.

The Hoppes Manufacturing Company, Springfield, Ohio, U. S. A.—Handsome catalogue of Hoppes steam separators and oil eliminators, together with short descriptions of live and exhaust-steam feed-water heaters and purifiers.

B. F. Sturtevant Co., Boston, Mass., U. S. A.—Catalogue No. 101, devoted especially to steel-plate exhausters for use in connection with the removal of chips from wood-planing machines. Diagrams of dimensions and capacities are given, and a number of valuable tables for use in connection with exhausters are appended.

Fraser & Chalmers, Chicago, Ill., U. S. A.—Catalogue No. 8, devoted to crushers and pulverizers, including the Comet, Blake, and Dodge crushers, and also improved crushing rolls and ball pulverizing mills.

The Novelty Iron Company, Canton, Ohio, U. S. A.—Catalogue of house-heating boilers for hot water, also tank heaters for supplying hot water for domestic purposes, laundries, etc. Steam boilers for house heating are also shown, and tables of capacities and dimensions given.

Westinghouse, Church, Kerr & Company, New York.—Small pamphlet giving a bird's eye view of the general business of the concern in installing complete steam, electric, refrigerating and other power-plants, with illustrations of steam and gas engines, boilers, stokers and other appliances.

U. Baird Machinery Co., Pittsburg, Pa., U. S. A.—A very handsome catalogue of general machine tools, printed in English, German, French and Spanish, and covering very fully the entire field of machine tools and shop equipments. A notable example of enterprise in catalogue-making and business effort.

The Winton Motor-Carriage Company, Cleveland, Ohio, U. S. A.—Neatly printed pamphlet giving an account of the record trip made between the cities of Cleveland and New York, a distance of 707.4 miles, in a Winton motor carriage in the time of 47 hours and 34 minutes. Extracts from the comments of the daily newspapers are given, and a general description of the Winton vehicles.

Lombard Water-Wheel Governor Co., Boston, Mass., U. S. A.—Descriptive pamphlet of the Lombard governor, Type F., with dimension sheet giving, in draftsman's elevation, a general view of the governor, showing the leading dimensions and construction.

The Chisholm & Moore Mfg. Co., Cleveland, Ohio, U. S. A.—Catalogue of October 1, 1899, devoted to pneumatic and hand-power chain hoists, cranes, and trolleys. With these are also noticed steel door-hangers and rail, standard rail joints, malleable-iron castings, and pneumatic riveting machines.

Henry R. Worthington, New York.—Special catalogue showing some recent installations of Worthington condensing apparatus, including central condensing plants, cooling towers, surface condensers, and special air pumps. Many handsome illustraions of actual installations are given, also sections of buildings showing arrangement of machinery.

Westinghouse Machine Company, Pittsburg, Pa., U. S. A.—A remarkably beautiful pamphlet devoted to the Westinghouse gas engines, giving a detailed description of the improved gas engines offered by the company, with views of the various parts and a complete description of the operations as they occur. Illustrations of coupled gas engines and electric generators are given, and examples of the applications of such sets to the production of light and power for country houses.

National Cash Register Co., Dayton, Ohio, U. S. A.—Neatly printed pamphlet giving an account of the educational and prize-awarding methods instituted among the employees of the company. An interesting study in the subject of the relations between employer and employed.

The Standard Tool Company, Cleveland, Ohio, U. S. A.—National export exposition issue of 1899 manual, a handy pocket book of information about tools, including tables of speeds, dimensions, etc., and interleaved with blank pages for individual memoranda.

American Engine Company, Bound Brook, N. J., U. S. A.—Pamphlet describing duplex compound engines of recent design, together with illustrations showing its simple construction, and its use in direct connection with electrical generators. Indicator diagrams are given to show the correctness of steam distribution attained.

The Rand Drill Company, New York.—Catalogues *(a)* of recent air and gas compressors; *(b)* of advance sheets from 1899 catalogue of air and gas compressors; and *(c)* of rock drills and mountings. These catalogues contain a vast mass of valuable reference information relating to machinery for compressing air and gases, and to rock drilling machines for every variety of work. Numerous views of important works are given, and the catalogues are model examples of the printer's art.

Ingersoll-Sergeant Drill Company, New York.—Catalogue No. 33, of air compressors for every variety of duty, with numerous handsome illustrations and much valuable information relating to the production of compressed air.

Joseph Dixon Crucible Company, Jersey City, N. J., U. S. A.—Two handsome catalogues, *(a)* of Dixon's graphite productions, including prepared graphite, lubricants, lead pencils, paints, etc.; *(b)* a paper on brazing by immersion, reprinted from the *Cycle Age*, showing the process of dip brazing for bicycle frames, and the use of the Dixon crucible in such work.

B. F. Sturtevant Company, Boston, Mass., U. S. A.—Catalogue No. 100, of Monogram blowers and exhausters, with many valuable tables relating to the delivery of air, weight of pipes, pressures and heads, and other reference matter.

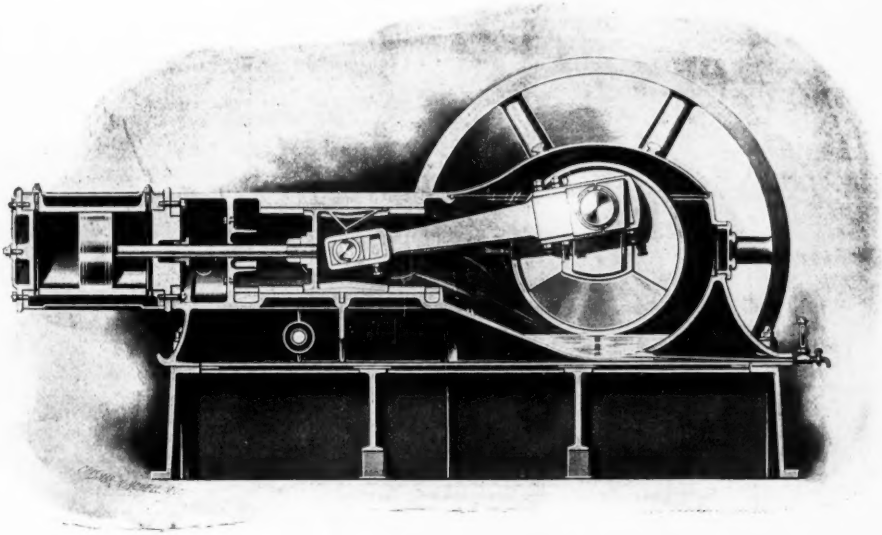
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Self-Oiling Automatic Engine.

THE half-tone illustration herewith represents a new internal self-oiling automatic engine constructed by the Ball Engine Co., Bound Brook, N. J. It will be seen that the oil is contained in a pocket in the bottom of the frame. The crank discs in revolving carry over a portion of this oil into a trough in the top of the frame, covered in by the hood. Thence the oil flows in streams into the main bearings, and is also carried by the radial holes to the crank pin.



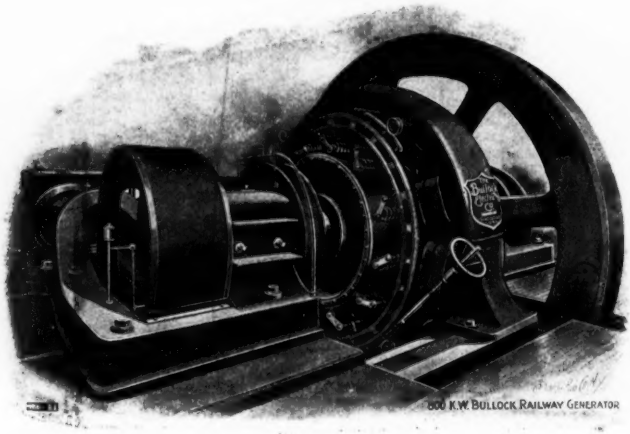
There are removable guiding plates, one on each side of the connecting rod at the ends of the guides next to the crank discs, so arranged that they make a slot through which the oil is guided directly into the crosshead, which has a large bell-shaped opening to receive it. The lower guides are so designed that the crosshead floats on the oil, and as the slides have large areas wear is practically eliminated in these parts. As the guiding plates guide the oil directly into the crosshead, the doors on the side of the frame may be taken away for the purpose of taking indicator cards or for examination of the crosshead, without the oil being thrown on the engineer or on the floor.

Another important feature in connection with the oiling device is the dividing wall between the cylinder-head and the crosshead chamber of the frame. By means of this the oil is kept cool and the water of condensation from the piston-rod stuffing

box is prevented from mixing with the oil in the frame, while access to the piston-rod stuffing box is gained by openings in the frame between the division wall and the cylinder head.

The principal advantages claimed for this system of oiling are: the oiling is automatic and positive, commencing when the engine starts and stopping when it is shut down, and requires no attention; there is uniform and copious lubrication of the various wearing parts, the passages being large and direct; there are no oil cups or tubes of any kind to clog up or become inoperative; the oil is not exposed to the open air or to contamination with foreign substances, as the oiling is entirely internal; there is no saponification or aeration, and the oil is kept cool and clean.

The Ball Engine Co. will furnish further particulars upon request.



800 K.W. BULLOCK RAILWAY GENERATOR

A New Street Railway Generator.

THE Bullock Electric Manufacturing Co. is entering the railway field with a complete line of engine type railway generators up to and including the 800 K. W. unit. Bullock railway generators will possess all of the features which characterize their standard, and also some new features that cannot be found in other machines. Among the more important may be mentioned a scheme for oscillating the brush holder mechanism in a direction parallel with the shaft. The movement is very slow and results in constantly changing the line of travel over the commutator face and thus removes all tendency to cut or groove it. The action is the same as secured by the end play of an armature in a belted generator, or that produced by the electro-magnetic device used at the end of shaft on rotary transformers.

The pole pieces and coils may be removed without disturbing the yoke or armature, and with two of them removed, it is possible to remove one or more armature coils, should repairs be necessary. The armature coils are made of continuous bars of copper, without joints between the commutator connections, which materially adds to the life of the machine. These coils are all thoroughly insulated, pressed and baked before being placed on the core, and no additional core insulation is necessary. All armatures are thoroughly ventilated by slots perpendicular to the shaft, through which the air rushes when the machine is in operation. A liberal rating permits of constant operation at full load with low temperature rise. One of the 800 K. W. machines has been sold to the Oakland Rapid Transit Company, of Oakland, Cal., and is shown in the engraving. This machine operates at a speed of 80 r. p. m. and at this speed develops 550 volts at no load. It is over-compounded for a rise of 50 volts at full load, making the full-load voltage 600.

A New Form of Exhaust Head.

One of the important features of a modern steam plant is an exhaust steam pipe head. To be effective it must thoroughly separate the water from the steam, and thereby prevent the constant spraying of roofs and walls, with consequent deterioration and expensive repairs. In the form

of exhaust head built by B. F. Sturtevant Co., Boston, Mass., and illustrated herewith, the principle of centrifugal force is utilized to secure perfect separation.

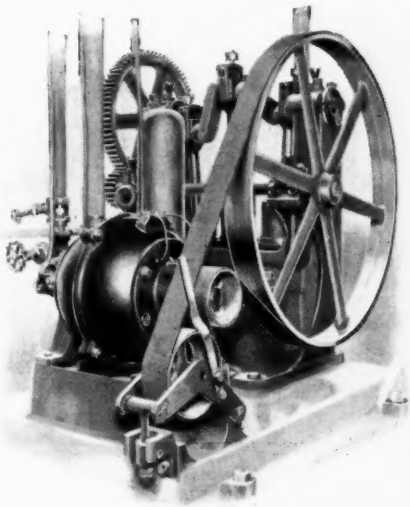
Dry exhaust steam weighs only .038 lb. per cubic foot, while water of the same temperature weighs 59.36 lb. per cubic foot. It is therefore evident that inasmuch as centrifugal force is proportional to the weights of the bodies in motion, the water will be thrown outward with 1,562 times the force exerted upon the steam, *i. e.*, 59.36÷.038 = 1,562.

In the Sturtevant exhaust head the steam passes up the interior pipes, is discharged tangentially close to the shell, and is thereby given a vigorous whirling motion. The entrained water, as well as the oil, flies outward, strikes the cool side and trickles down to the outlet at the bottom. The steam, now perfectly dry, finds ready escape through the central opening above. The action is positive and absolute. Perfect separation must be the result. These heads are built in sizes to fit pipes from 1 inch to 20 inches. All sizes above 10 inches are flanged instead of tapped.

The B. F. Sturtevant Co. will send a special circular to those desiring detailed information.

Gould Pumps and Lundell Motors.

The application of the Lundell motor to machine driving has been so extensive and varied as to be almost universal. While by no means a new departure, the accompanying illustration shows a very practical use to which this motor has been put. The outfit is designed for general hydraulic work in factories, residences, hotels and the water works of small towns. The pump is of the Gould's Triplex pattern. It is self-contained, compact, durable and takes up but little space. The motor is bolted to the bed plate of the pump, insuring rigidity and ability to withstand the sudden shocks and jars inevitable in such service. Automatic control is effected, depending upon the amount of water in the



tank, operating when the water gets low and stopping when it is high. The Lundell motor shown is of the steel clad type and, by reason of its simplicity, compactness and immunity from damage, is specially adapted to this class of work. It is moisture and dust proof and requires a minimum of attention. If it is desired the motor may be geared to the pump, instead of belted. The Sprague Electric Company, New York, manufacture the Lundell motor in sizes from 1-16 h. p. to 200 h. p., and they will be pleased to mail catalogue and any desired information to those interested.

Planing and Matching Machine.

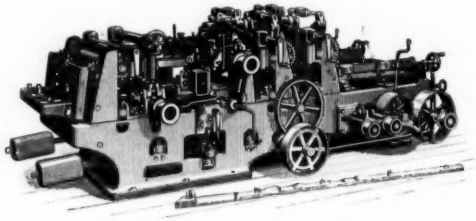
THIS is a late type of heavy combined machines for general planing mill purposes, for all kinds of surfacing, jointing, tonguing and grooving, factory flooring, car decking, heavy dimension stock, molding, etc. It will plane four sides up to 30" wide and 8" in thickness, or it will work simultaneously three sides of two pieces of material of uneven thickness up to 12" wide and 8" thick.

The frame is very massive, and that portion supporting the working parts is braced by a sole-plate or girt of extra length. All parts are accurately planed and joined by heavy bolts.

The cylinders are two in number, made from solid steel forgings of fine quality, have four faces slotted to receive two or four knives, and chip-breaking lips for working cross-grained lumber. The upper cylinder is mounted in a heavy yoked frame, has journals 2¼" in diameter, and runs in self-oiling bearings 10½" long. It has double-flanged pulleys close to bearings on each end, fitted on taper bearings, and secured with wrought nuts. The cylinder-raising screws are outside of the frame, and are fitted with ball-bearings and a device for quickly taking up lost motion in the screw caused by wear of the threads. The lower cylinder is mounted in a heavy yoked frame, has 2¼" journals that run in self-oiling bearings 10½" long, and is vertically adjustable at each end. It is driven by flange pulleys at each end.

The matching works are heavy. The arbors are of steel, 1¾" in diameter where the cutter-heads are applied, and revolve in long, self-lubricating bearings, both of which are adjustable vertically and horizontally, and are rigidly locked in any desired position by a lever conveniently located outside the frame. The top plate of each matcher hanger is detached from the main casting for convenience and economy. The weighted matcher clip has adjustable toe, is hinged to the matcher hanger, and produces uniform pressure on the material. Shaving hoods are provided, which can be swung out of the way to give access to the heads.

The feed works consist of six rolls, 8" in diameter, driven by a train of gearing, each gear on a shaft extending through the machine and running in babbitted bearings. The expansion gears on feed rolls are inside the frame. The screws for raising the rolls do not revolve, the rolls being mounted in sleeve housings that travel on the screws. This makes the roll adjustment very easy, as the pressure weights do not have to be lifted. The upper feed rolls



before the upper cylinder are divided in the center for the purpose of feeding simultaneously two pieces of material of uneven thickness through the machine. These divided rolls are heavily weighted, and may be aligned at any time, or adjusted out of line with the platen to lead the lumber to the center guide. It has three speeds of feed; viz., 30', 45', and 60' per minute.

The pressure bar before the upper cylinder is divided and adjustable to and from the cut, and has chilled toes, reducing wear to a minimum. The bar after the cut is adjustable for difference in thickness of material worked. The bars before and after the lower cylinder are adjustable to and from the cut, and are vertically adjustable for varying depths of cut. The bar over the lower cylinder is adjustable on heavy stands, and securely locked in position.

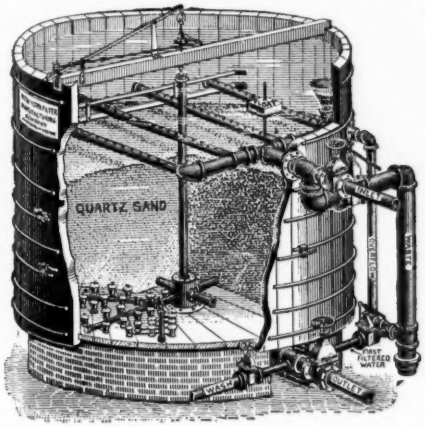
This machine is equipped with a new belt-tightening apparatus for both cylinder and side-head belts quickly adjustable while the machine is running, and permitting the

use of endless belts. By the use of this apparatus 2" stock may be matched and the belts stand at least 10" apart on the countershaft.

Built by J. A. Fay & Co., Cincinnati, Ohio, who will furnish full illustrated details to interested parties.

A Sectional Gravity Filter.

We illustrate herewith the New York Filter Manufacturing Company's sectional washing gravity filter, which is the type recently ordered by the Great Northern Paper Company for their mills at Millinocket and Madison, Me. This is the largest filter plant order that has ever been given by a paper mill, having a daily



capacity of 16,000,000 gallons. Each filter is 17 feet in diameter by 8 feet high, built of cypress, and has a filter bed of about 4 feet in depth. The patented sectional washing feature is embodied in this filter. On the floor of the filter is shown a four-way valve, which permits one-quarter of the filter bed being washed at a time, thus securing a powerful reverse current, through one-quarter of the bed, which thoroughly scours and cleans the material. After each of the four sections has thus been cleaned, all four ports in the valve are opened by means of the lever shown at top of cut, which permits a reverse current to flow up through the entire bed.

The system of strainer cone valves in the bottom is so proportioned that when all four ports of the valve are opened the entire bed is raised about a foot, like a piston, before the filtering material is broken up and churned, and after each washing the bed is left the same as new.

In addition to paper and pulp mills using these filters there are 140 cities filtering their entire supply. Other large plants are used in prominent textile mills, shirt factories, sugar refineries, hotels, asylums, office buildings, public institutions, and in fact in all establishments where clear water is desired.

To meet the growing foreign demand the parent company has recently formed a foreign company, with offices in London, Moscow and Paris, and others will be speedily established.

Illustrated descriptive catalogues will be furnished free upon application to the New York Filter Company, New York.

A Correction.

In this department of the October number of The Engineering Magazine there appeared a description of the Cincinnati Shaper Co.'s back geared crank shaper, while the cut accompanying it illustrated a triple geared rack shaper made by the same house. The Cincinnati Shaper Co., Cincinnati, Ohio, will be glad to furnish the proper illustration on request, or will send views and descriptive matter of either of the machines to interested parties.

Industrial Notes.

The F. D. Cummer & Son Co., of Cleveland, the manufacturers of the well-known Cummer mechanical dryers, report the following sales for the past two months: Laflin & Rand Powder Co., Pleasant Prairie, Wis., one special dryer to dry 1½ tons of nitrate of soda per hour; United States Navy, Indian Head, Md., one special dryer to dry one ton of nitrate of soda per hour; Trent Valley Peat Fuel Co., Peterborough, Ont., one "Salamander" dryer to evaporate 2½ tons of water per hour from peat fuel; Warren-Burnham Cement Co., Craigsville, Va., one style "F" dryer to dry 2½ tons of slack coal per hour; Peerless Portland Cement Co., Union City, Mich., one "Salamander" dryer to evaporate two tons of water per hour from marl.

Among shipments they report: John Mc-

Gillen, Chicago, one Cummer portable railroad asphalt paving plant to lay 2,000 yards of 2 in. topping per day of 10 hours; Société Anonyme de Ciments de Vise, Brussels, Belgium, one "Salamander" dryer to dry fifteen tons of chalk per hour and another "Salamander" dryer to dry four tons of clay per hour; T. Herbert Wymonde, of Vancouver, B. C., one style "F" dryer, to dry fifty tons of fish scrap per day; Pennsylvania Salt Mfg. Co., Natrona, Pa., one three-tunnel, six-track tunnel system complete for drying iron ore briquettes; Vulcanite Portland Cement Co., Phillipsburg, N. J., one style "F" dryer for drying seventy-five tons of slack coal per day; William Krause & Sons Cement Co., Martins Creek, Pa., one style "F" dryer for drying 2½ tons of coal per hour; Premier Tripolite Co., North Sydney, N. S., one special dryer for drying tripoli.

The Union Boiler Tube Cleaner Co., Pittsburg, Pa., has recently finished the largest contract ever awarded for cleaning boilers, being for twenty-two water-tube boilers, containing an aggregate of ten miles of four-inch tubes. They have just shipped their eighth machine to England and Scotland. The initial machine for export had been shipped just one year previously. One of the latter was a repeat of the first order.

Visitors to the National Export Exposition, at Philadelphia, should not fail to see the exhibit of Harrison Bros. & Co., Inc. It is located in the west arcade, to the right of the Auditorium, and may be easily found by looking for the revolving, variegated screw. The wood-work, forming the back of the exhibit, is finished in their interior decorative stain, and their various products are so arranged as to give some idea of the relation of one to the other. The effect is still further heightened by an illuminated cave formed of crystal alum, at the base of the display. A copy of a handsome booklet, entitled "A hundred years of good paint making," is given as a souvenir to those interested in paints and chemicals.

Messrs. Westinghouse, Church, Kerr & Co. report a very brisk month's demand for Westinghouse steam and gas engines. During the past month they have entered orders for export to foreign countries for eighty-five Westinghouse steam and gas engines aggregating 6,000-H. P. These contracts are spread over a wide area, including England, France, Germany, Australia, New Zealand, Chile, Mexico, Argentine Republic, Russia, South Africa, Sweden, Finland, Holland, Cuba, Patagonia, Austria, Belgium, Egypt and Canada. Domestic orders also reflect the expanding business of the country. During the month, eighty-five engines have been sold, aggregating over 6,000-H. P. Among the orders we note a 500-H. P. Westinghouse compound steam engine for the Elmira Knitting Mills; two 280-H. P., 3-cylinder, Westinghouse gas engines, for the Detroit Copper Mining Co., are shipped to Morenci, Arizona. A 200-H. P. Westinghouse compound steam engine, direct connected to a Westinghouse electric generator, is being constructed for the Standard Steel Works, Burnham, Pa.; a 200-H. P. Westinghouse compound steam engine will be installed for the Dupont Powder Works at Carney's Point, N. J. The Cresonia Powder Co., Schuylkill County, Pa., are installing a 35-H. P. Westinghouse steam engine. The Baldwin Locomotive Works have ordered two 260-H. P. Westinghouse compound engines direct connected to two Westinghouse electric generators. These make about forty Westinghouse engines operating in the Baldwin Locomotive Works. The Spreckles Sugar Refinery, Philadelphia, are installing another large Westinghouse steam engine, making nearly ninety Westinghouse engines in their sugar works.

The American Engine Co., of Bound Brook, have received an order from the Hollingsworth & Whitney Co., of Waterville, Me., for the entire engine equipment of their new mill, consisting of two special 300 h. p. double engines and a 125 h. p. engine, and also a complete 75 k. w. electric generating plant.